POWER

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Would You Give Yourself a Job?

UP to now you have put in your shift every day and have managed by divers tactics to convince the Boss that you are an "all-around hustler." You have been the recipient of several substantial wage increases, and all things considered you feel that you have a wonderful job—nothing much to do but watch the clock for quitting time and the calendar for payday. You punch in on the job at 6:59, spend a half-hour in changing your clothes and getting ready for work; from 7:30 until noon you "require" several drinks of water (but there is intemperance even in the water cup). You stop at various times to "roll one," go over and chat with the other fellow, etc., and take five to fifteen minutes extra for lunch. Did you ever notice how loud that whistle sounds—very easy to hear at noon, but even though you are in identically the same place at 12:30, you don't always hear it then. Queer, isn't it?

Now, then, let go of yourself and imagine that you have been appointed superintendent of your department, and while you muse just imagine that your old self, as another fellow, comes into your office seeking employment. You know that self better than anyone else; he's the fellow that has the "creed" that the company owes him a living. Remember him, don't you? Sure you do. All right, now on the square, all things considered, if you were the Old Man, would you give yourself a job?

Contributed by J. J. JAHOBART

Development of Steam-Boiler Baffles

By ALBERT A. STRAUB

Power-plant engineers are frequently required to develop modifications and changes in the standard method of baffling boilers in order to meet smoke-ordinance requirements of cities and also to increase the economy and flexibility of units operating under their direction. In developing the different types of baffles described, the ultimate purpose in each case was to obtain maximum economy and capacity consistent with the primary feature for which the baffle was designed.

A TYPE of installation not well adapted to burning high volatile coal without producing objectionable smoke when operating efficiently or at high capacity is shown in Fig. 1. The plant where these units are installed is located close to the center of the city and was a generous producer of objectionable smoke. At this plant, owing to floor space and building restrictions, no relief could be sought in increasing the combustion space by raising the boilers, lowering the stokers or by increasing the Dutch oven; all efforts toward smoke elimination had to be confined to modifications and changes of the baffle arrangement and to slight modifications of the furnace construction.

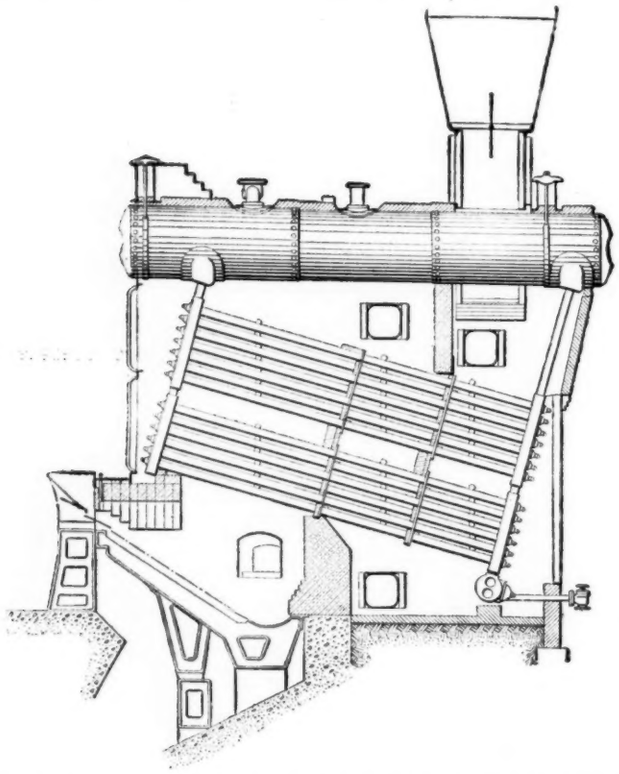


FIG. 1. SETTING NOT ADAPTED FOR BURNING HIGH VOLATILE COAL

The first unsuccessful attempt was made to solve this problem by the installation of the baffle and furnace arrangement shown in Fig. 2. This arrangement embodied the features deemed at that time (1910) essential to smoke elimination; namely, extremely high furnace temperature and the profuse use of refractory surface in the furnace and combustion chamber. This arrangement had exactly the opposite of the desired effect; it produced as much smoke as the original arrangement, seriously decreased the capacity and efficiency of the boiler and involved excessive furnace maintenance costs.

Efforts toward smoke elimination were then abandoned for several years until 1914, when some experiments were conducted with the original arrangement, using steam jets and over-fire air admission in different ways. The results of these experiments were unsatisfactory when any considerable percentage of rating was developed at good efficiency.

The next step was the first made toward the successful solution of the problem, being a modification of the arrangement shown in Fig. 2 and consisting of replacing the tile encircling the tubes over the furnace with tile which exposed the lower half of the tube directly to the furnace heat, the piers not having been renewed when they burned out. Steam jets were added directly over the coking plate and at the throat piece of the stoker; some improvements were also embodied in the stoker by which it maintained an even fire over the entire grate. This arrangement accomplished its primary object, smoke elimination, but still left much to be desired in the way of capacity, efficiency of operation and flexibility.

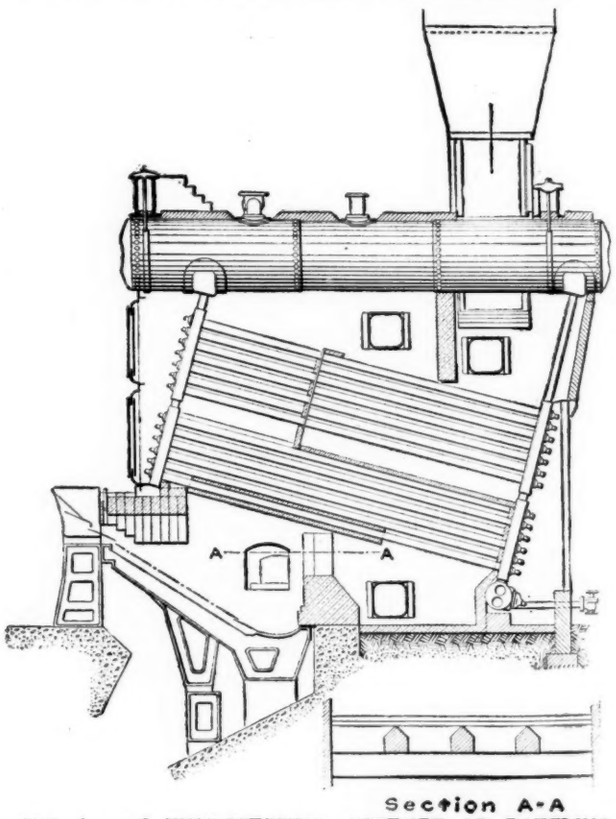


FIG. 2. AN UNSUCCESSFUL ATTEMPT AT BAFFLING

Realizing where the shortcomings of the modified arrangement of Fig. 2 were, an arrangement such as shown in Fig. 3, and to which this type of boiler lent itself admirably, was installed. This arrangement accomplished all the desired effects: namely, gave smokeless operation at good efficiency and capacity consistent with draft, permitted of considerable abuse in handling fires without producing objectionable smoke, and possessed a high degree of flexibility in operation. The accompanying test table shows the results of tests conducted on the various arrangements of baffles as described.

The curve shown in Fig. 6 shows a comparison of the

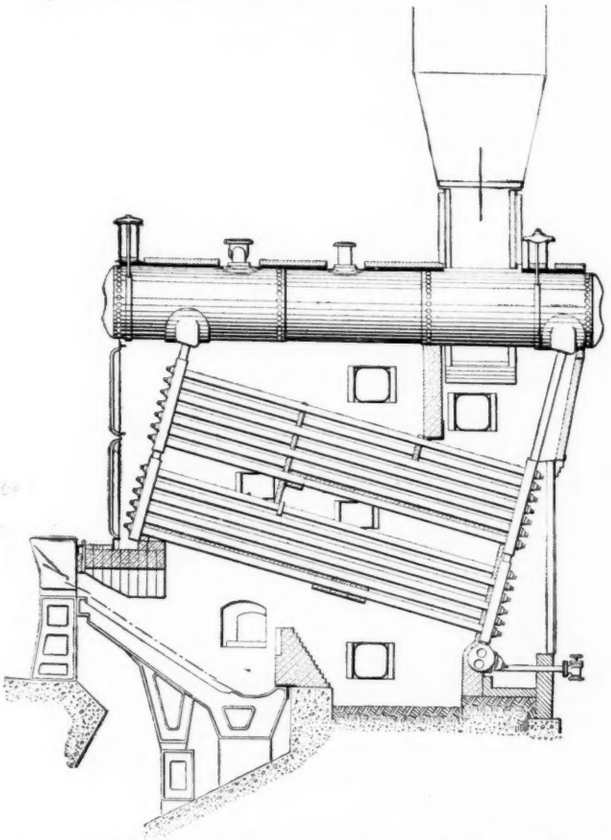


FIG. 3. THIS BAFFLING GAVE THE DESIRED RESULTS

efficiency-capacity curves with a modified arrangement of Fig. 2, the baffles on the lower row of tubes being the same as in Fig. 3, and the arrangement shown by Fig. 3, both boilers being connected to stacks of the same height by the same arrangement of breeching; the increase in capacity and efficiency obtained are of special note.

A type of baffle developed in the later years and applied to Stirling boilers, in order to eliminate smoke production, increase efficiency and decrease the amount of refractory arch required in the furnace, is shown in Fig. 4. Test made with this arrangement gave excessive flue-gas temperatures at 150 per cent. rating and above, resulting in a change in location and closing up of baffle openings as shown by Fig. 5. With this arrangement of baffles the capacity of the unit was not decreased, but the temperature of the escaping gases was decreased 60 deg. F. at 150 per cent. rating and 70 deg. F. at 210 per cent. rating, with a corresponding increase in efficiency. A further change was made in this baffle arrangement after the tests had been completed by placing the first baffle back of the second row of tubes and extending the last baffle down 24 in. toward the mud drum, as shown by baffle in cross-section Fig. 6; all other baffles were left as shown. This change reduced the temperature of the escaping gases 50 deg. F.

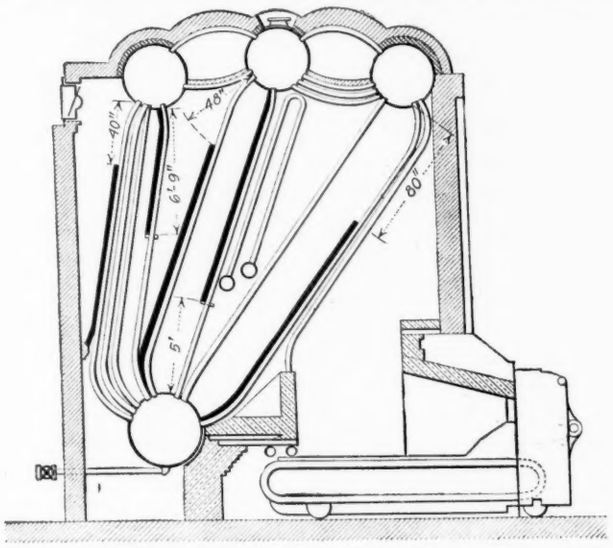


FIG. 4. BAFFLES TO INCREASE EFFICIENCY AND MAINTAIN CAPACITY

at the higher ratings with a consequent increase in efficiency.

The ratio of efficiency to capacity for this unit, baffle as shown by Fig. 5 (baffle shown solid), is given by the curve shown in Fig. 7. [Note—Tests and baffle changes on this unit at direction of Mr. J. E. Bell, consulting engineer, 111 Broadway, New York.]

Baffles arranged in boilers designed to operate at

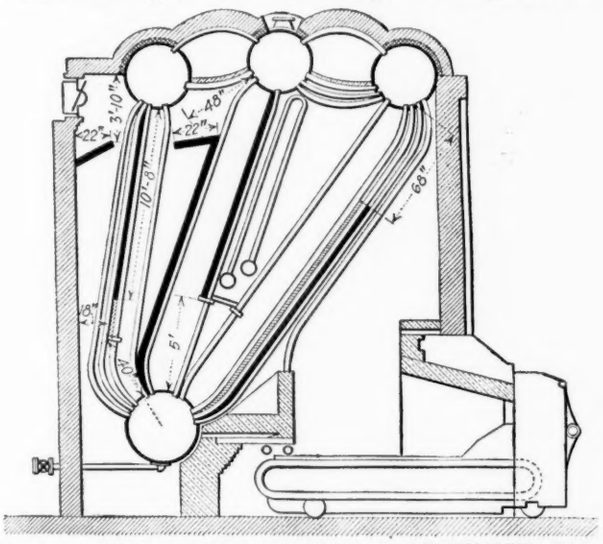


FIG. 5. BAFFLES THAT CAUSED A DECREASED GAS TEMPERATURE TO CHIMNEY

moderate capacities sometimes impose undue restrictions and cause excessive draft losses when the stoker equipment of the boilers is changed in order to develop high capacities. In order to maintain efficiency and flexibility it usually becomes imperative in such cases to change the baffle arrangement.

A cross-sectional elevation of a boiler baffled to de-

TESTS OF 18-TUBE WIDE, 13-TUBE HIGH B. & W. DOUBLE-DECK WATER-TUBE BOILER, EQUIPPED WITH RONEY STOKER 80.8 SQ.FT. GRATE AREA

Test to determine	Capacity	Min. Smoke Production with Max. Draft	Capacity	Min. Smoke Production with Max. Draft	Capacity	Economy	Capacity	Economy
Date	7-25-14	7-22-14	7-7-11	7-5-11	9-18-14	8-6-14	3-22-15	3-26-15
Duration, hours	8.0	9.0	11.0	11.5	9.0	9.0	10	10
Baffle and furnace arrangement	Fig. 1	Fig. 1	Fig. 2	Fig. 2	Fig. 2	Fig. 2	Fig. 3	Fig. 3
Kind of coal	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh
Size of coal	¾ Nut-Slack	¾ Nut-Slack	¾ Nut-Slack	¾ Nut-Slack	¾ Nut-Slack	¾ Nut-Slack	¾ Nut-Slack	¾ Nut-Slack
Average Pressures and Temperatures:								
Steam pressure by gage, lb. sq.in	146	152	150	151	149	152	150	148
Barometric pressure, in., hg	29.14	29.41	29.15	29.15	29.50	29.25	28.96	29.47
Draft at damper, in. of water	0.78	0.99	0.69	0.67	0.97	0.27	1.27	0.57
Draft end last pass, in. of water	0.57	0.68	0.46	0.43	0.62	0.20	0.80	0.37
Draft in furnace, in. of water	0.35	0.42	0.20	0.18	0.28	0.09	0.30	0.15
State of weather	P. Cloudy	Clear	Cloudy, Rain	Clear	Cloudy, Clear	Clear	Cloudy, Clear	Cloudy
Temperature outside air, deg. F	83	89	81	95	79	86	34	31
Temperature of fireroom, deg. F	98	105	104	115	96	102	80	75
Temperature feedwater entering boiler, deg. F.	101	101	154.5	147.4	97	97	86	91
Temperature of gases leaving boiler, deg. F	580	584	595	595	560	540	615	550
Quality of Steam:								
Percentage of moisture in steam	0.44	0.83	1.95	2.20	1.28	2.50	1.95	2.38
Quality of steam (dry steam unity)	99.56	99.17	98.05	97.8	98.72	97.50	98.05	97.62
Total Quantities:								
Weight of coal as fired, lb	18,791	20,639	19,270	18,014	19,992	12,670	28,759	20,967
Per cent. moisture in coal	6.22	3.31	2.50	1.00	4.97	5.72	3.11	3.68
Total weight of dry coal fired, lb	17,622	19,956	18,788	17,834	18,998	11,945	27,865	20,195
Total weight of ash and refuse, lb	2,683	2,538	3,665	2,549	2,153	1,896	4,435	3,798
Total combustible consumed, lb	14,939	17,418	15,123	15,285	16,845	10,049	23,730	16,397
Per cent. ash and refuse to dry coal	15.2	12.7	19.5	14.3	11.3	15.9	14.8	18.8
Total weight of water fed to boiler, lb	148,240	161,040	142,662	127,465	147,005	97,012	209,451	156,176
Total weight of water evap. cor. for steam moist., lb	147,588	159,704	140,450	125,235	145,123	94,587	205,367	152,459
Factor of evaporation	1.160	1.160	1.104	1.112	1.164	1.165	1.176	1.170
Total equivalent evaporation from and at 212° F., lb	171,202	185,257	155,057	139,261	168,923	111,094	241,512	178,377
Hourly Quantities and Rates:								
Dry coal fired per hour, lb	2,203	2,217	1,708	1,550	2,111	1,327	2,787	2,019
Combustible consumed per hour, lb	1,867	1,935	1,375	1,327	1,872	1,117	2,373	1,640
Dry coal per square foot of grate surface per hour, lb	27.3	27.5	21.1	19.2	26.1	16.4	34.5	25.0
Water evaporated per hour corr. steam moist, lb	18,449	17,745	12,768	10,890	16,125	10,510	20,537	15,246
Equivalent evaporation per hour, from and at 212° F., lb	21,400	20,584	14,096	12,110	18,769	12,344	24,151	17,838
Equivalent evaporation per hour, from and at 212° F. per sq.ft. water heating surface	5.52	5.31	3.76	3.23	4.84	3.18	6.22	4.60

Proximate Analysis of Coal:	As Fired	Dry	As Fired	Dry	As Fired	Dry	As Fired	Dry	As Fired	Dry	As Fired	Dry	As Fired	Dry	As Fired	Dry
Condition																
Fixed carbon, per cent	51.81	55.23	53.27	55.09					54.68	57.54	55.38	58.74	55.00	56.77	50.77	52.71
Volatile matter, per cent	31.61	33.72	32.30	33.41					29.48	31.02	28.62	30.36	30.44	31.42	28.11	29.18
Moisture, per cent	6.22		3.31		2.50		1.00		4.97		5.72		3.11		3.68	
Ash, per cent	10.36	11.05	11.12	11.50	9.79	10.04	10.78	10.89	10.87	11.44	10.28	10.90	11.45	11.81	17.44	18.10
Sulphur, per cent. (separately determined)	1.54	1.64	1.35	1.42	1.41	1.45	1.68	1.70	1.39	1.46	2.07	2.20	1.56	1.61	1.54	1.60
Analysis of Refuse from Ashpit:																
Combustible, per cent	33.58		46.47		50.00		43.50		23.79		32.39		43.68		24.22	
Non-combustible, per cent	66.42		53.53		50.00		56.50		76.21		67.61		66.12		75.78	
Calorific Value:																
B.t.u. per lb. of dry coal by calorimeter	13,415		13,273		13,298		13,282		13,292		13,437		13,372		12,442	
B.t.u. per lb. of combustible by calorimeter	15,081		15,000		14,783		14,905		15,009		15,081		15,162		15,317	
Capacity:																
Evaporation per hour from and at 212° F.	21,400		20,584		14,096		12,110		18,769		12,344		24,151		17,838	
Boiler horsepower developed	620		597		409		351		544		358		700		517	
Rated boiler horsepower	375		375		375		375		375		375		375		375	
Per cent. of rating developed	165		159		109		93.6		145		95.5		187		138	
Economy Results:																
Water fed per pound of coal as fired, lb	7.89		7.80		7.40		7.04		7.35		7.66		7.28		7.45	
Water evaporated per pound dry coal fired, lb	8.38		8.00		7.47		7.02		7.64		7.92		7.37		7.55	
Equivalent evaporation from and at 212° F. per pound, dry coal fired	9.71		9.28		8.25		7.81		8.89		9.30		8.67		8.83	
Equivalent evaporation from and at 212° F. per lb. of combustible	11.46		10.63		10.25		9.11		10.27		11.05		10.18		10.88	
Efficiency:																
Efficiency of boiler furnace and grate, per cent.	70.3		67.8		60.2		57.0		64.9		67.0		62.2		68.9	
Efficiency of boiler and furnace, per cent	73.7		69.3		70.6		63.5		65.0		71.1		65.2		69.9	
Smoke Data:																
Per cent. black smoke as observed	41.8		31.6		19.4		7.9		9.5		11.7		13.9		7.6	
Violations city smoke ordinance, period of test	17		11						2		0		3		1	
Ordinance \ 2 min. or more smoke 60% black (No. 3) Violation / Ringelmann chart or denser in 15 min period																
Analysis of Dry Gases, by Volume:																
Carbon dioxide, CO_2, per cent	10.4		9.8		8.1		7.2		11.0		10.1		10.7		11.2	
Oxygen, O_2, per cent	8.7		9.2		11.4		12.6		7.9		9.0		8.3		7.6	
Carbon monoxide, CO, per cent	0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrogen, N_2, per cent	80.9		81.0		80.5		80.2		81.1		80.9		81.0		81.2	

velop high capacity at moderate gas speeds is shown in Fig. 9. The baffle in this boiler was so designed that 54.2 per cent. of the bottom tube length would be exposed to the radiant heat of the furnace and the baffle so arranged that practically constant gas travel velocity would be secured at 275 per cent. rating. This boiler, as originally installed, was equipped with stoker and

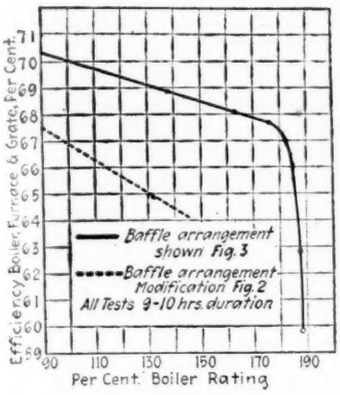

Efficiency Boiler, Furnace & Grate, Per Cent.
Per Cent. Boiler Rating
Baffle arrangement shown Fig. 3
Baffle arrangement-Modification Fig. 2
All Tests 9-10 hrs. duration

FIG. 6. EFFICIENCY-CAPACITY CURVE WITH BAFFLING AS PER FIGS. 3 AND 4

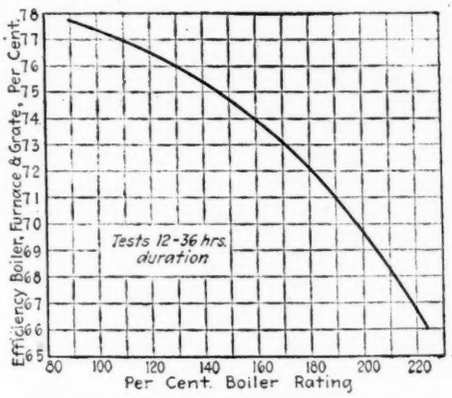


FIG. 7. RATIO OF EFFICIENCY TO CAPACITY OF BOILER BAFFLED AS IN FIG. 5

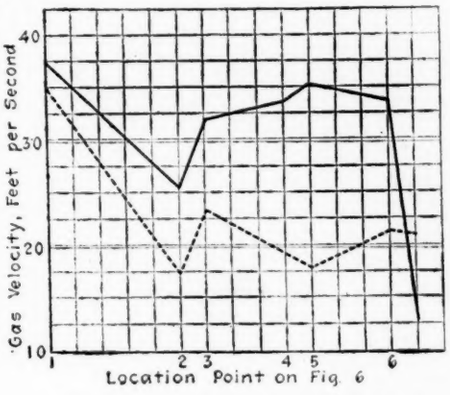


FIG. 8. PROBABLE GAS VELOCITY AT 275 AND 175 PER CENT. OF RATING

capable of developing about 175 per cent. rating at gas speeds as shown by the dotted line of the curve, Fig. 8, with original baffle location and the original size of damper opening. With the change of the stoker equipment and baffle arrangement, the size of the damper opening and the breeching area were also increased. The boiler was originally installed 5 ft. 6 in. from the floor line to the bottom of the front header, but when being equipped with a different type of stoker it was raised so that this distance is now 11 ft. 6 in. This

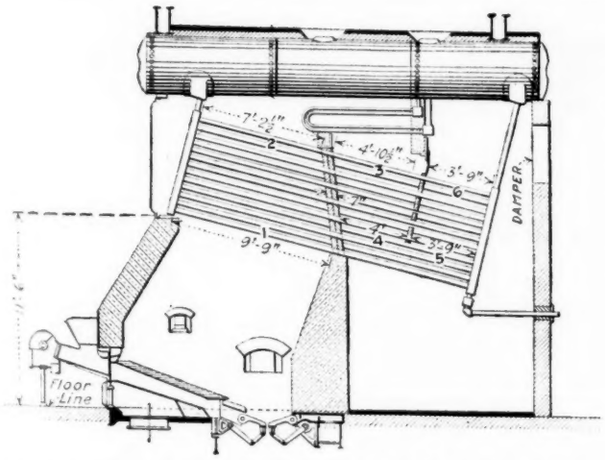


FIG. 9. BOILER SETTING AND BAFFLING FOR HIGH CAPACITIES WITH MODERATE GAS SPEEDS

unit has on test maintained high rating at good efficiency.

The probable gas-travel velocity curve with the boiler operating at 275 per cent. rating, 70 per cent. efficiency, with coal of 13,400 B.t.u. dry, and rearrangement of baffles is shown by the full line, Fig. 8. The probable gas-travel velocity curve for the boiler operating at 175 per cent. rating with the same fuel and at the same efficiency, with baffles in position, as installed for the old arrangement, is shown by dotted line.

A Fuel-Saving Experience

By W. D. Ball

Considering the widespread knowledge of power-plant economics, it may not be possible to present startling innovations, but patriotism added to loyalty should urge all to keep in touch with and practice the best-known methods, to study and seek for improved ways and means and to be always alert for possibilities for fuel saving offered by any peculiar condition existing in each special sphere of activity. The following briefly sets forth a few things that were done in a small plant serving one of the essential war industries.

This is a high-explosives plant and is therefore essentially different from most commercial enterprises in that, for the sake of safety, it covers a large territory and has necessarily long steam and transmission lines and a comparatively small power equipment. The principal products are picric acid and tetranitromethylaniline. There is also an oil refinery for making the "intermediates," such as benzol, toluol, xylol, etc., a saltpeter refinery, acid houses for the manufacture or concentration of sulphuric, nitric and hydrochloric acids, a naphthalene factory and a plant for the manufacture of black dye, which is a byproduct from picric acid.

The boiler equipment consisted of some Stirling and some horizontal return-tubular boilers, all equipped with hand-fired furnaces. The actual evaporation before any changes were made was in the neighborhood of 7½ lb. with coal containing more than 14,000 B.t.u. per pound. The oil from which the benzol and toluol is made is distilled by means of high-pressure steam and the vapor passed through water-cooled condensers. As the refineries are situated near the power house, the condensed steam from the stills was returned there by steam traps. Because of the possibility of oil from leaky steam coils in the stills being carried over, these traps did not discharge directly into the feed-water heater, but into an open elevated tank and thence by gravity to the heater. The result was the loss of all the heat in the condensate represented by the difference between about 350 and 212 deg. This loss was promptly stopped by discharging sufficient cold water into this tank to condense all the steam liberated, which resulted in a rise in the temperature of the feed water from 150 deg. to over 200. The next important step was the installation of stokers under the Stirling boil-

ers, which increased their efficiency considerably. Then we replaced the stationary grates under the horizontal boilers with shaking grates. We also connected the damper rods around to the front of the boilers so that the damper regulation would receive more constant attention.

The combination of improvements has brought the evaporation up a little above 10 lb. and, as is often the case, the simplest things have produced the greatest results. In our own case, the longest stride in the journey from 7½ to 10 lb. evaporation was the installation of boiler-efficiency meters and the use of a plaster on the settings to prevent the infiltration of air. These things have cost very little and together have brought the evaporation up a pound or more. The efficiency meter of course needs watching—in fact that is what it is for—and if intelligently watched and its readings translated into action will be sure to bring about an average increase in CO_2. It indicates constantly the condition of the fire and baffles, and in general the clinkers and soot, and is a good guide to damper regulation. All this is accomplished without having to teach the firemen anything more scientific than that the relative positions of two different-colored oils in a draft gage show when there are holes in the fire, when the coal bed is too heavy or too light, etc. The meter is interesting to the fireman because he learns that he does not have to poke the fire unless the meter tells him to. It reduces his work and increases efficiency at the same time.

We found that a coating applied to the boiler brickwork helped toward the highest economy. We thought our settings were as tight as it was possible to get them, yet the efficiency increased immediately after a coating was applied and the boiler at the end of the breeching farthest from the stack gave an excellent account of itself in the matter of capacity, whereas before it always lagged behind the others. Up to about two months ago our heat balance was very good, but recently an increased load at the oil refineries and the addition of another air compressor in the power house caused a surplus of exhaust steam. To take care of this we intend to install a trap on top of the boilers, to which the returns from all the refinery traps will be led, thus returning all that water directly to the boilers at about 300 deg., leaving the heater free to handle the cold makeup water only. This is expected to increase the average feed-water temperature considerably. The boiler-feed water is now first fed through after-coolers in the refineries. These cool the benzol and toluol to a point where all loss by evaporation is eliminated and at the same time raise the boiler feed-water temperature before it enters the heater to 80 or 85 deg. We hope by these means to obtain an actual evaporation of 10½ to 11 lb. of water per pound of coal.

Referring to the question of overloads, there arose a condition last winter where we were called upon, for nearly a month to take care of a boiler load which during the day shift of eight hours was nearly 60 per cent. in excess of our total rated boiler capacity and during the remaining hours about 40 per cent. in excess. To handle this load we put a turbine-driven blower under each Stirling boiler and built some temporary removable gates in front of the ashpits, which were removed when dumping ashes. This answered very well for a temporary arrangement, and as the load was light on Sunday, we were able to get one or two boilers off for cleaning every week. We have five plants here in a group tied together electrically by a 2200-volt three-phase system on the primary side and 550 volts on the power distributors. There is also a connection to one of the public-service companies. The steam, water and air lines of two of the plants are connected together, which is a great assistance at times.

Ammonia Discharger for Refrigerating Plants

The discharger shown in Fig. 1 is an ejector with two inlets, one for ammonia and one for water, both of which are controlled by valves closed on their respective

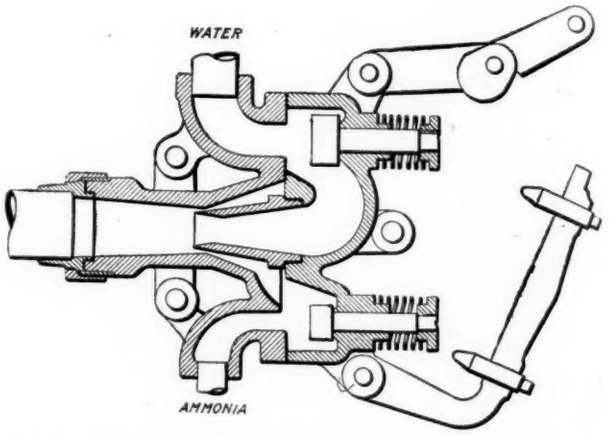


FIG. 1. DISCHARGER FOR REFRIGERATING PLANTS

seats by screws carried in a swinging yoke which, in turn, is held closed by a latch. A small wire cable attached to the trigger on the valve, when pulled at a remote safety station, causes this latch to trip, allowing the yoke to swing back, thereby releasing the valves. The valves under the impulse of the pressure of the water and ammonia and the springs will then open, al-

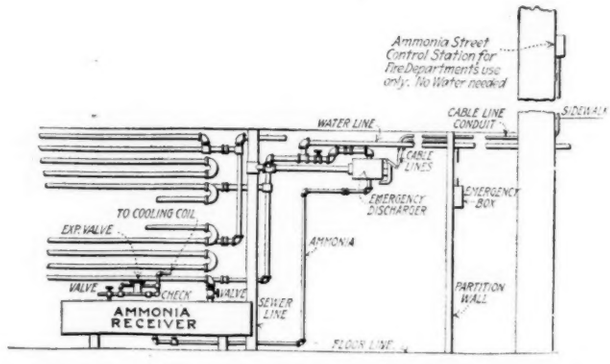
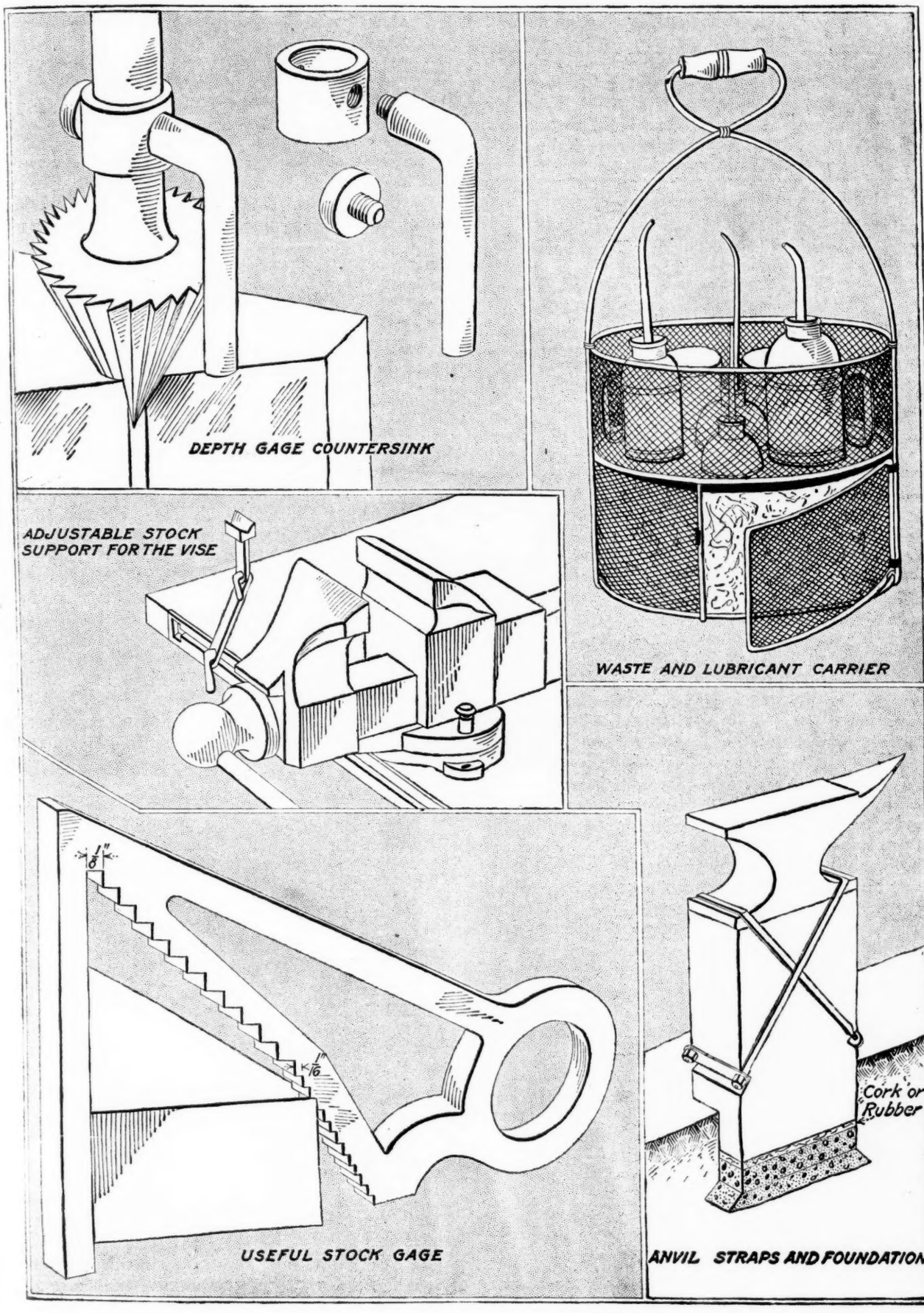


FIG. 2. DISCHARGER CONNECTED TO THE SYSTEM

lowing the liquids to combine and mix through the ejector, which discharges through a pipe connection to an inconvenient place, say to the sewer. Fig. 2 shows how the discharger is connected to an ordinary refrigerating plant. This device has been brought forth by W. M. Schwenker, 340 East 92nd St., New York City.

Handy Kinks for the Power Plant



Care of Heating and Ventilating Equipment—III

By HAROLD L. ALT

In which the author treats of the proper firing of heating-plant boilers. Smokeless combustion the most efficient combustion. Devices for preventing smoke.

THE greatest single factor in the operation of any heating plant is the firing of the boilers. Unless the firing is carefully and properly done, good results cannot be expected and will not be attained and proper firing involves both skill and labor. Herein lies the operating engineer's chance to shine, for the method of firing and care displayed are distinctly up to him. Moreover, a good man with a plain grate can—by proper and efficient stoking—produce better results than a careless or ignorant fireman with the best of equipment.

There are at the present time two all-impelling motives which render the matter of proper firing extremely important—the rapidly increasing cost of coal and the difficulty in securing it. It is hard to get good firemen

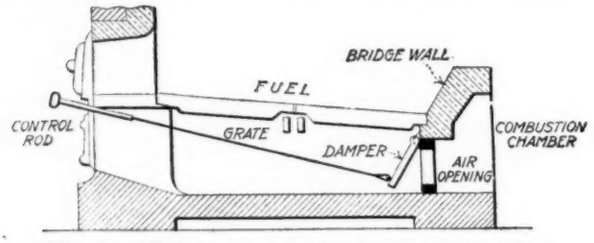


FIG. 1. EXTRA AIR TO COMBUSTION CHAMBER

on account of the present industrial conditions due to the war, and for the foregoing reasons it is becoming increasingly difficult to get good results with the ordinary grates, so that certain apparatus for firing of more or less special and automatic character is now proving to be the best solution of the problem. Heating boilers designed for operation at low pressure are primarily arranged for burning anthracite, and in Eastern cities, heating plants of considerable size are still burning hard coal, but it is not at all unlikely that the coming winter will see more plants endeavoring to use bituminous coal than ever before and the results are likely to be far from satisfactory.

Other things being equal smokeless combustion is the most efficient combustion whatever the fuel may be. Smoke means unconsumed carbon—choking flues with soot, greater consumption of coal and complaints from near-by property owners. How, then, can the fuel be burned efficiently, that is, smokelessly? Regarding the prevalence of smoke, particularly from heating boilers, Martin A. Rooney, smoke inspector for Nashville, Tenn., says: "Practically all the large cities of the country now have stringent ordinances directed against the emission of dense smoke from all classes of public buildings, including apartment houses, schools, etc., in which the commonly called house-heating boiler is used." By house-heating boiler is meant usually the low-pressure, steel firebox, or the cast-iron sectional firebox boiler, and it has been amply demonstrated that these types are probably the greatest contributors to the volumes of smoke in our large cities. When an attempt is made to burn soft coal in such equipment, the rules of perfect combustion are violated to a much greater extent than in power boilers for the reasons that the heating boiler has a much lower rate of combustion and the temperature of the furnace is therefore lower, while the space provided for combustion is insufficient and no adequate provision is made for the mixture of air and the volatile gases, and these volatile gases are brought into contact with the cooler surfaces of the boiler before combustion can be completed.

These difficulties are inherent in such apparatus and, although they may be mitigated by the use of larger-sized boilers than otherwise required and by careful firing, other means are successful and among the most common is the down-draft grate. Therefore the engineer should be prepared to properly fire not only the common up-draft grates and to operate the ordinary smoke-preventing devices for these grates, but also down-draft grates as used in connection with various types of boilers. What, then, is the best method of firing, assuming a common up-draft grate and ordinary soft coal? Primarily, the cause of smoke with any fuel on any grate is the lack of the right amount of oxygen at the right place and the escape of combustible gases (carbon monoxide) without being ignited; therefore, to avoid such conditions, air must be admitted in such quantity and at such points as to make a proper mixture and the ignition of all escaping gases must be made as nearly positive as possible.

On the common up-draft grate there are several methods of firing that produce good results. One of

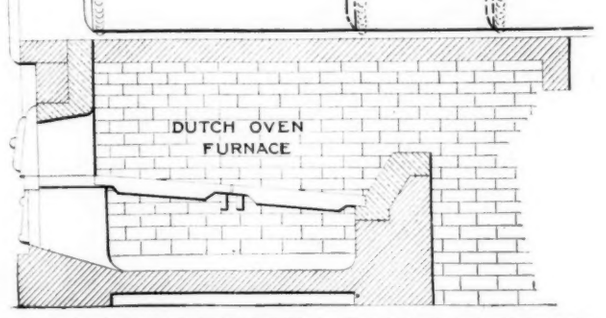


FIG. 2. RELATIVE POSITION OF BOILER TO FURNACE

these is stoking alternate sides or doors of the furnace (or in large units, the four quarters of the furnace taking each quarter in rotation) with a frequent and light spreading of coal, depending upon the incandescent coal of the adjoining section to ignite and consume any gases that would tend to escape if the entire grate area were covered with fresh coal at the same time. Another is what is known as the coking method and consists of piling the fresh fuel at the front of the grate so as to coke and emit a large portion of the gases, and

these gases in passing across the incandescent bed of coals lying farther back on the grate are ignited and consumed. When a charge of fuel is thoroughly coked, it is pushed backward into the furnace and fresh fuel piled at the front as before. Both methods presuppose that sufficient air is allowed to enter through and also above the fire bed to support combustion. For this

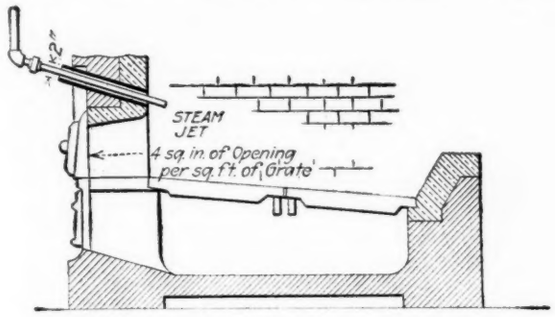


FIG. 3. STEAM JET OVER FUEL BED

reason it is often found that fires will burn much better with the slide damper of the fire-door open or with the door not closed quite tight, although a more desirable place for the admission of air is at the point of gas formation. It is particularly difficult to fire a heating plant efficiently during mild weather where the load will vary anywhere from 5 to 25 per cent. of the maximum full load. Many operators build up too hot a fire, then throttle it down by closing the draft at the ashpit doors, thus preventing the passage of a proper quantity of air, resulting in incomplete combustion and the gases formed passing up the stack as CO and in some cases by opening the firing doors with the stack damper open so there is a rush of cold air over the fire and up the stack, carrying with it nearly all the heat generated. Excess air defeats economy.

Fire Should Be Cleaned When It Is Bright

The greatest care should be taken in cleaning fires, as this is a time when smoke, cinders and ashes are most likely to cause complaints from near-by residents. So far as possible clean the fire when it is bright and the fuel fully ignited throughout—not just after stoking when there is a lot of green fuel in the furnace requiring skillful handling to prevent smoke. After cleaning the fire bring the entire remaining incandescent fuel to a good even bed and either sprinkle a thin coating of fresh fuel over a portion of the bed or start the coking process again.

A simple way to increase the air supply to the combustion chamber consists of cutting a hole in the ordinary bridge-wall as used with horizontal return-tubular boilers and controlling this opening by a damper, as shown in Fig. 1. This allows air to bypass the fuel bed and enter the combustion chamber, helping in the complete combustion of the gases. It is claimed that this expedient in some cases nearly doubles the efficiency of the furnace and eliminates all smoke. At any rate it behooves every operating engineer to give the matter a trial to see if it is suitable to his particular boilers, for it is necessary in a properly operated plant that smokeless combustion be maintained. Many other ideas have been worked out in connection with up-draft grates such as the dutch oven that may be entirely under the boilers with a deflector arch, as illustrated in Fig. 2, and the same with semiextension or full extension, as shown by the dotted outline of the boiler in various positions in relation to the furnace. The arch becomes so hot that any burnable gases are kept hot enough by these heated surfaces to be ignited even though they have escaped from the furnace proper.

Another device intended to prevent smoke is shown in Fig. 3, where a steam jet is set at an angle above the furnace door to discharge down toward the top of the fire, and air is admitted through adjustable slides in the fire-doors. Other designs use the steam jet alone without special provision for air admission above the fire.

The standard setting for horizontal return-tubular boilers for low pressure is practically the same as used for high-pressure work, and such boilers are generally used for large low-pressure installations and have the advantage of being so constructed that a battery of any number of units can be installed without spaces between individual boilers, while many other boilers must be set singly or at most in batteries of two.

Flues Should be Cleaned at Least Once a Week

It is too often assumed that the engineer understands the importance of keeping the flues and smoke passages clean, but this is a detail often neglected in low-pressure plants probably on account of the lack of high-pressure steam with which to blow out and clear the passages. To get reasonable efficiency out of a heating boiler, the flues should be cleaned at least once a week and oftener is better. Few plants, however, receive this desirable attention so frequently. On the question of smoke and complying with local ordinance requirements disputes sometimes arise as to the duration and quality of the smoke since there are grades and graduations of color from zero to the blackest ebony. Of the many methods suggested to test the density of the smoke, that known as the Ringelmann Scale is perhaps the simplest and is reasonably satisfactory. This system involves the preparation or purchase of charts, sections of which are shown in Fig. 4, consisting of black lines run in two directions of such varying thicknesses as to produce certain percentages of black. The percentages of black

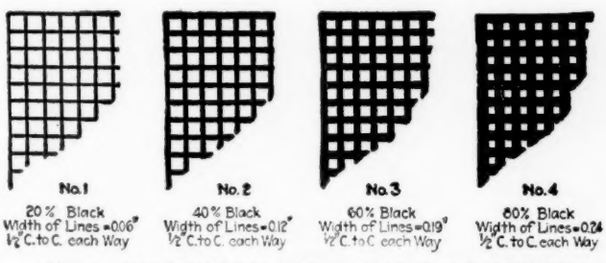


FIG. 4. RINGELMANN'S SMOKE GRADING CHARTS

generally used are No. 1, 20; No. 2, 40; No. 3, 60; and No. 4, 80. No. 5 would be solid black, indicating the densest kind of black smoke produced. In using these charts the procedure is to place them far enough from the eye for the black lines to blend into the white, producing an even shade, and comparing this with the color of the smoke emitted from the stack, selecting the one most nearly corresponding to it. The element of time also enters in, for smoke of a given quality may

be permitted for a given length of time under the local ordinance. In such cases readings are usually made every quarter of a minute and the results plotted on a sheet of 240 divisions or multiples thereof so that the smoke emission for an hour or more can be indicated graphically. Such a typical sheet would appear in some cases, as shown in Fig. 5, for a very smoky chimney.

To compare the average density between one stack and another near-by the average percentage of density

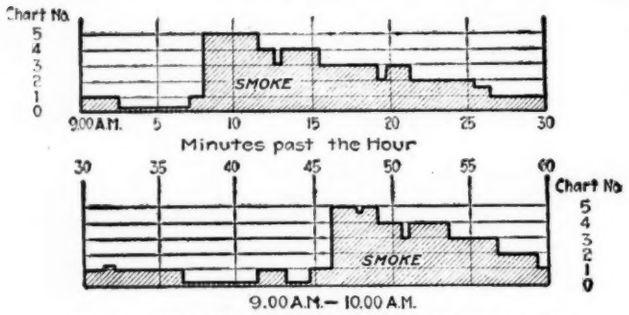


FIG. 5. GRAPHIC RECORD OF SMOKE EMISSION

must be computed for the two stacks, as follows:

$$\textit{Percentage of density} = \frac{\textit{Stack Unit} \times 20}{\textit{Stack Minutes}}$$

in which percentage of density is taken as meaning the percentage of light prevented in passing through the smoke; as, for instance, in smoke corresponding to Chart 2 the percentage of light shut off is 40. A smoke unit is one minute of smoke equal to chart No. 1. A minute with smoke of the density corresponding to chart No. 2 is equal to twice as much as a minute at No. 1, or two units; similarly, one minute at No. 3 density equals three units and at No. 4 four units. From this it is seen that three minutes of No. 2 + two minutes of No. 3 + six minutes of No. 4 would be

$3 \times 2 = 6$ *smoke units*
$2 \times 3 = 6$ *smoke units*
$6 \times 4 = 24$ *smoke units*

36 *smoke units total*

Stack-minutes is the number of minutes per stack during the observation. Thus one stack watched for five minutes equals five stack-minutes, but three stacks watched for five minutes would equal fifteen stack-minutes. For example, suppose a stack emits

Density	Time, Minutes	Units
No. 5	2	10
No. 4	3	12
No. 3	5	15
No. 2	4	8
No. 1	2	2
None	44	0
Total	60	47

Then by the formula,

$$\frac{47 \times 20}{60} = 15\tfrac{2}{3}\ \textit{per cent. average density.}$$

It is generally assumed that a stack is performing satisfactorily when it emits not over a total of 3 minutes per hour of smoke at density No. 3 or over, and when the average density is not greater than 5 per cent. This standard is readily obtainable with good smoke-preventing furnaces and proper firing.

Power-Plant Electric Hoists

Small electric hoists, which are adapted to almost every kind of work involving hoisting, form an economical means of handling loads of from one-half ton to five tons. They can be suspended from a fixed point, shear pole, jib crane, trolley running along an overhead track, or small traveling crane. The trolley or crane when used can either be pulled along by hand or operated by means of a motor. Fig. 2, on the opposite page, shows a few uses to which the hoist can be put about the power plant.

These hoists are controlled from the floor by means of pendant ropes. A brake, which is automatically applied when the controller is returned to the off position, holds the load suspended, and a safety switch automatically cuts off the current when the hook is hoisting to its safe limits of travel.

Special mechanical and electric features are used in the construction of the motors to suit the service. The direct-current motors are modifications of the series-wound crane type. The alternating-current motors are

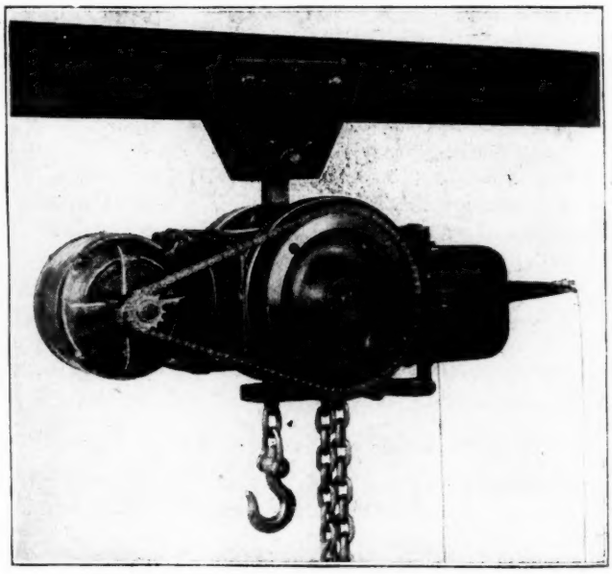


FIG. 1. MOTOR-DRIVEN HOIST

of the polyphase squirrel-cage type with high torque rotor windings. Three-quarter horsepower motors are used for ½-ton hoists and 7-hp. motors for 5-ton hoists, the ratings being figured on a 30-minute basis.

The controllers of the drum type are designed to break heavy currents without burning the contacts. When the tension on the control ropes is released, a spring returns the controller to the off position.

The hoists (Fig. 1) are built by the Yale & Towne Manufacturing Co., New York City, and are equipped with the Westinghouse electric apparatus.

According to information received from one of the leading East coast shipyards, says *Marine Engineering*, the best day's work on a shell with pneumatic riveting is 700 rivets of ¾-in. diameter, and for hand work, under the same conditions, 430. An average day's work is considerably less than this, and may be taken as being 510 rivets with pneumatic riveters against 264 with a hand squad, for work on all parts of one ship.

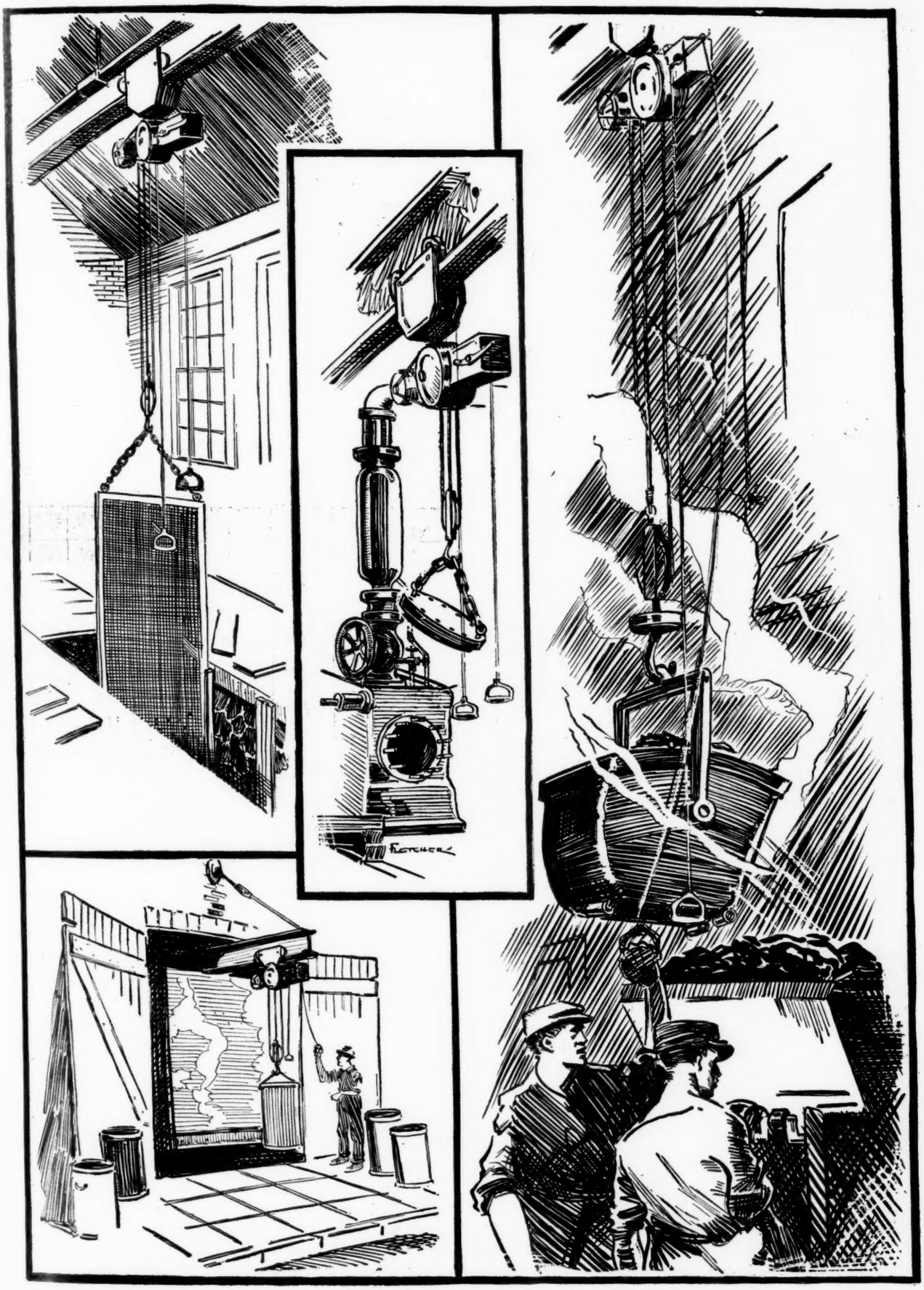


FIG. 2. INDICATING A FEW USES TO WHICH THE HOIST CAN BE PUT, SUCH AS HOISTING INTAKE SCREENS, CYLINDER HEADS, ASH CAN AND COAL BUCKETS

Operation of Direct-Current Motors in Parallel or Series

By GORDON FOX

There are many cases where two motors may be applied to a single drive, being equivalent to one motor. The two may be connected in parallel or in series. Some of the considerations leading to the use of two motors in parallel are discussed.

WHERE continuous operation is imperative, the use of two motors in parallel offers possibilities for emergency operation with a single motor. Sometimes each motor is capable of handling the entire load. This means a double investment. It is often preferable for the two motors combined to equal the normal load, a single motor running at reduced speed and perhaps slightly overloaded. Instances of applications of this sort are the hoist on a ladle crane or the tilting motion of a metal mixer in a steel mill, etc.

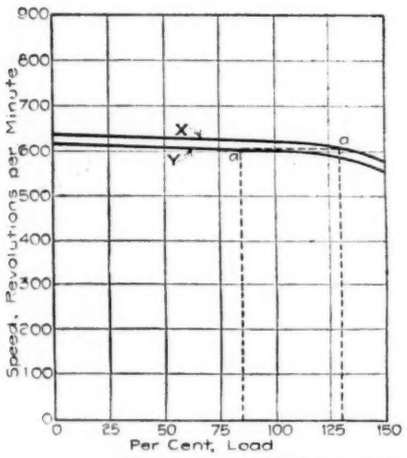


FIG. 1. SPEED-LOAD CURVES FOR TWO SHUNT MOTORS IN PARALLEL

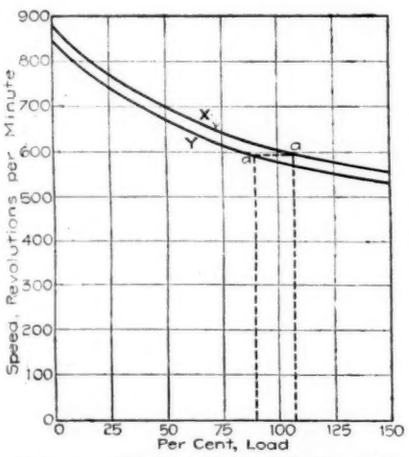


FIG. 2. SPEED-LOAD CURVES FOR TWO COMPOUND MOTORS IN PARALLEL

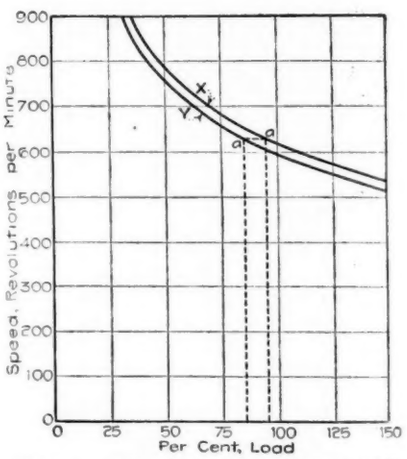


FIG. 3. SPEED-LOAD CURVES FOR TWO SERIES MOTORS IN PARALLEL

Two small motors may be preferable to one only because of their size. The smaller units may be standard and duplicate others in a plant, whereas a single large motor would be special to the plant and might require separate spare parts to be carried. It may frequently be possible to combine motors on hand rather than to purchase a new larger unit. Mill-type motors are not built in very large units, it usually being preferable to combine two smaller ones. Smaller motors require less space and may be fitted in where space is at a premium. They weigh less, are more easily handled and may be more readily dismantled and their parts removed.

Not infrequently, a machine is spread out, the main load occurring at separated points that must run in unison. Or the machine may be symmetrical, in reality comprising two parts that must operate together. Such cases lend themselves to the use of two motors with attendant decrease of shafting and transmission equipment. A case of this kind may be seen in the bridge of a traveling crane, where two motors drive the two end trucks but are coupled by a shaft running across the bridge. A more extreme case is that of the ore bridge, the two ends being moved by motors operated in parallel without mechanical connection other than that through the track wheels and tracks.

A group of machines may be driven by two motors connected in parallel so that together they handle the load during peak conditions. The larger motor alone will perhaps care for ordinary service, while the smaller one is used for overtime and night work. There are a number of such possibilities for parallel operation.

Some of the reasons for using two motors in parallel apply equally well if the two are connected in series. There are other advantages peculiar to the series connection. The control of two motors, in series, is simple and inexpensive, being practically equal to that required for one of the two motors. Two motors in series develop starting torque equal to that of two connected in parallel, but with less total current input, since the same current passes through both. It is a common practice to connect in series two 230-volt motors, placing the combination across 230 volts. The motors thus attain but half normal speed. Where the drive is through gears, the ratio with the motors in series will be half that when they are in parallel if the same running speed is to be attained. The same starting torque is developed by a motor, whether operated alone or in series or parallel with another. The power required to accelerate a machine under fixed conditions is a definite quantity. With current input to the motors restricted to a given limit, the same time will be required to accelerate the machine, whether the motors are connected in series or parallel. It does require more power, however, to accelerate a motor itself to full speed than to half speed, as inertia of the armature and pinion must be overcome. Consequently, in rapidly reversing drives where the motors attain considerable speed and their inertia is a serious factor, series connection may lead to more rapid operation.

Motors are sometimes arranged for operation either in series or in parallel. Traction service is a notable example. Here the motors are brought up to half speed while connected in series. If higher speed is desired, they are then connected in parallel. This arrangement is simple and economical of power as it reduces the resistance losses of acceleration. Another instance of series-parallel operation is the screw-down application in steel mills. The motors may be arranged for series connection while screwing down, where slow speed, short movements and accurate adjustment are desired. When lifting the rolls, the motors may be connected in parallel, thus securing maximum speed.

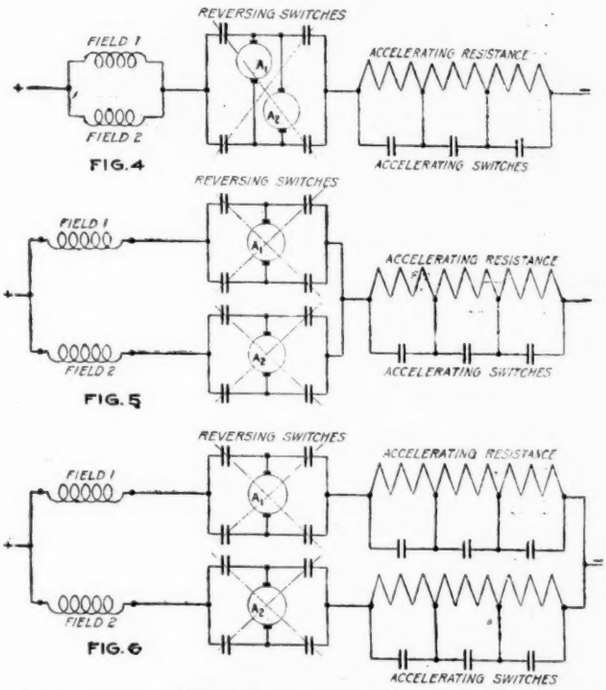
When motors are to operate together, the first requirement is that each assumes its proper share of the load. If they are to be connected in series, it is necessary that they be rigidly connected mechanically, since otherwise one might assume more than half voltage and speed up while the other slowed down. Motors connected in series must of course pass the same current. If mechanically connected, they will operate at the same speed (with equal gearing) and will have equal voltage at their terminals. They must therefore divide the load equally. It will be seen that, with this arrangement, the units must be of equal size.

When motors connected in parallel drive a single load, each is connected across the line and is free to pass its own load current independently. Load division then becomes a matter of relative speed-power characteristics. The two machines together will drive the load at a speed dependent upon their combined pulling ability. Each will take a load corresponding to this speed on its own speed-power curve. Let us see how this works out.

Curve *X* of Fig. 1 is the speed-load curve of a shunt-wound direct-current motor. Curve *Y* of the same figure is the speed-load curve of another similar motor. These motors are mechanically connected together and to the same load. Being connected together, they will run at the same speed, which, for a given load, will be 610 r.p.m., as shown by the dotted line *aa*. This speed corresponds to approximately 85 per cent. full load with one of the motors, whereas with the other, this speed corresponds to about 30 per cent. overload. It is evident that these motors will not equally divide the load. If it is possible to change their relative speeds, as by a change of gears, or by turning off the pulley of one motor, it may be possible to attain equal load division. The motors are then carrying the same load, but operate at slightly different speeds. It should be noted that with this arrangement it would be possible for the two motors to drive proportionately at one load but to fail to do so at another. This is due to differences in speed regulation. A motor having good regulation tends to hold up the speed as the load comes on. If such a motor be parallel with one having a marked falling off in speed under load, the first will assume proportionately more and more of the work as the load increases. Hence such a drive is not satisfactory. For this reason it is not desirable to parallel mechanically a shunt-wound motor with a compound-wound or a squirrel-cage motor with one of the slip-ring type.

In Fig. 1 two shunt motors are shown having similar characteristics yet differing in values. It is a difficult matter to find two motors having identical characteristics. Although they may be built to the same specifications, their performance will vary. The air gaps may be a little different, affecting the flux. The shunt coils may easily differ slightly in resistance. The cast portions of the magnetic circuits may differ; the brush positions or brush contact may not be the same, or the leads to one motor may be longer and have greater voltage drop. There will always be some differences in performance, ordinarily not noticeable, but sufficient to have a marked influence when motors are paralleled. It might be noted that induction motors are likely to more closely duplicate performance than are direct-current machines.

The same general conditions hold for compound-wound and series-wound motors as with shunt-wound machines. Fig. 2 shows the curves for two compound motors of like design, while Fig. 3 shows the curves for two similar series motors. It is to be noted that, owing to greater pitch of the curves, representing poorer



FIGS. 4 TO 6. DIFFERENT SCHEMES OF CONNECTING SERIES MOTORS IN PARALLEL

speed regulation, compound motors operated in parallel will divide the load more equally than shunt motors, while the load division with series motors will generally be quite good. Squirrel-cage induction motors are comparable with shunt motors in this respect, while the wound-rotor types are similar to compound machines, dividing the load more uniformly the poorer the speed regulation.

It may be of interest to note a few points concerning the control of motors connected in series or in parallel. Shunt motors are not often operated in series, the balancer set on a three-wire system being perhaps the most common application. Here the shunt fields are connected across the outer lines or interconnected, and a starting rheostat is inserted in the armature circuit. When shunt motors are operated in parallel, it is satisfactory to use a single starting rheostat large enough for the two motors. If fuses are installed ahead of the

starter, they will not protect the individual motors, and it is well to place the fuses in each motor circuit. Squirrel-cage induction motors may be connected in parallel from the same auto starter, but the fuse protection will be faulty and overload relays in the individual motor leads will be preferable.

Series motors, when connected in series, may be controlled by a single drum or magnetic controller, the same as would be used for one motor. There are several ways to control two series motors connected in parallel, not all desirable. It is possible to use a single controller, connecting the series fields in parallel and the armatures in parallel as indicated in Fig. 4. The fault with this arrangement rests in the difficulty in securing equal division of current through the two series fields. These fields are of low resistance and slight differences in them or their leads will cause unequal division of current. The field passing the lesser current will be the weaker, and the corresponding armature will run faster and tend to assume most of the load. It is found in practice that motors connected in this way divide the load very poorly, one motor taking nearly all the load in some cases.

Two series motors may be connected in parallel according to the scheme of Fig. 5, using two sets of directional switches with but one accelerating resistor and one set of accelerating switches. This arrangement is entirely satisfactory when accelerating the motors from rest, but is not good for "plugging" or reversing service because the local loop circuit comprising the two armatures and two series fields is subject to some voltage due to differences in the counter-voltages of the two motors when they are plugged. The local voltage may be small, but is sufficient to send enormous currents through the local low-resistance circuit.

The best arrangement for parallel operation of two series motors is shown in Fig. 6. Here we have separate directional switches for each motor and separate resistors. The presence of the resistors in the local loop circuit greatly reduces the local current when "plugging." An arrangement such as shown in Fig. 6 may be obtained either through the use of two entirely separate controllers or by a single controller having two-pole magnetic switches throughout, one switch of each unit being for each motor. The first-mentioned arrangement is preferable as being standard and offering advantage in case of failure of one controller; while the double-unit controller offers some advantage by insuring the same rate of acceleration for both motors, a condition that may not be attained in case two separate controllers are used.

A Short Talk on Boiler Efficiency

By CHARLES H. BROMLEY

If you could get the efficiency of your boilers up from 45 to 70 per cent. efficiency you would save a third of every ton of coal shoveled. You could shut down one 200-hp. boiler for every three in service.

OF TWO similar plants in the same neighborhood, using the same kind and grade of coal, one may get an equivalent evaporation of 7 lb. of water per pound of coal and the other get 9 lb. per pound of coal. The efficiency of one is better than that of the other. And the reason is that one makes better use of the heat supplied to it in the coal than does the other.

The efficiency simply tells how much of the total heat in the coal, or other fuel, gets into the water and steam in the boiler.

Efficiency is, of course, expressed in percentage. The heating value of the coal is always taken as 100 per cent., because it is all the heat you have with which to make steam. The efficiency is a ratio and, like any ratio, simply tells the relation between two quantities. As related to boilers it tells the relation between all the heat you have on hand to make steam with and all the heat you have in the water and steam in the boiler. It is expressed:

$$\textit{Efficiency} = \frac{\textit{Heat in the Steam per pound of fuel fired}}{\textit{Heating Value of one pound of fuel}}$$

The heat absorbed per pound of coal is obtained by multiplying the equivalent evaporation from and at 212 deg. F. per lb. of coal by 970.4.

The heat required to make a pound of steam depends upon the pressure at which the steam is made, and upon the temperature of the feed water. In some plants the steam pressure is 80 lb., in some it is 100, or 150 or 200 lb. And the feed water going into the boiler may be 60 deg. F. in one plant, 100 deg. in another, 210 or 212 deg. F. in others. So there must be some standard by which the performance of all plants may be compared. And this standard is the *equivalent evaporation* from and at 212 deg. F. It is simply this: We find the number of pounds of water that could be evaporated from 212 deg. into steam at 212 deg. by the heat required to evaporate one pound of water from the feed-water temperature as we find it in any plant into steam at the boiler pressure used in the plant.

We have a relation of two quantities, you see. And this relation is a ratio, and the ratio is called the *factor of evaporation.* Suppose that in your plant the feed-water temperature is 200 deg. and the boiler pressure 115 lb. What would the factor of evaporation be?

The factor of evaporation is found by ordinary arithmetic, expressed for convenience as follows:

$$F = \frac{(H - t) + 32}{970.4}$$

in which

F = Factor of evaporation;

H = Total heat in 1 lb. of steam at boiler pressure;

t = Temperature of the feed water.

Reference to the steam tables gives the total heat at 115-lb. pressure as 1188.8 B.t.u. Therefore, using figures in this formula instead of letters we have

$$F = \frac{(1188.8 - 200) + 32}{970.4} = 1.052$$

Suppose that in your plant you were getting an evaporation of 8.5 lb. of water per pound of coal. What would the equivalent evaporation be?

Multiplying the actual evaporation by the factor of evaporation gives the equivalent evaporation. Then, 8.5 × 1.052 = 8.94 lb.

The boiler-efficiency formula should now be clear.

But boiler efficiency, as it concerns the power-plant crew, is not a matter of formula, but of skill and care in operation.

Let us consider efficiency from this viewpoint. A boiler horsepower is 34.5 lb. of water evaporated from and at 212 deg. F. in an hour. The heat required to evaporate a pound of water at 212 deg. into steam at 212 deg. is 970.4 B.t.u. So a boiler horsepower is 970.4 × 34.5 = 33,479 B.t.u.

If we had just 33,479 B.t.u. with which to produce each boiler horsepower, and we produced each boiler horsepower with this amount, the boiler efficiency would be 100 per cent. We might prove that this way:

$$Efficiency = \frac{Heat\ absorbed}{Heat\ available} \times 100, \text{ or}$$

$$Efficiency = \frac{33,479}{33,479} \times 100 = 1 \times 100 = 100\ per\ cent.$$

Of course 100 per cent. efficiency cannot be attained. There are too many sources of unavoidable losses. But 80 per cent. is had in some unusually good plants, and it is a poor one where 65 per cent. cannot be had most of the time; 60, 50 and even 40 per cent. are common in poorly operated or badly designed plants. Let us see what inexcusably poor boiler efficiencies mean in coal lost or wasted. That is what interests us in these days when steam-power plants must save the greatest part of 50,000,000 tons of coal this year that there may be enough to make ammunition, artillery, helmets, ships, guns, transport and the many things our soldiers and sailors need to win the war.

Assume that 70 per cent. efficiency is possible in your plant. Then for every 47,827 B.t.u. you should get a boiler horsepower. It figures out this way:

$$\frac{33,479}{0.70} = 47,827\ B.t.u$$

Then for a ton of coal having a heating value of 13,000 B.t.u. per lb. you should easily get $\frac{13,000 \times 2000\ lb.}{47,827}$ = 543.6, say 540 boiler horsepower; that is, you should keep a 540-hp. boiler going at rated capacity for one hour on this much coal—or, say, five 108-hp. boilers going at rated capacity for an hour.

But if the efficiency is only 45 per cent., how much will a ton of this same coal do? The number of heat units needed to make one boiler horsepower at 45 per cent. efficiency is $\frac{33,479}{0.45}$ = 74,398 B.t.u., and we would get only $\frac{13,000 \times 2000\ lb.}{74,398}$ = 350 boiler horsepower, or 543.6 — 350 = 193.6 boiler horsepower less than when operation was not overwasteful. Think of it! Under this careless operation one-third of the coal fired is wasted. Out of every ton 667 lb. is wasted. How much is 667 lb. of coal?

It is $2.67 with coal at $8 per ton.

It would make nine 3-in. shells for the boys fighting for you over there.

If you could prevent its loss per ton in your plant and get your efficiency from 45 up to 70 per cent., you could shut down one 200-hp. boiler for every three 200-hp. boilers you have in service, and still carry the load.

It would make 83 soldiers' helmets.

It would send a soldier 500 miles to sea on his way to France.

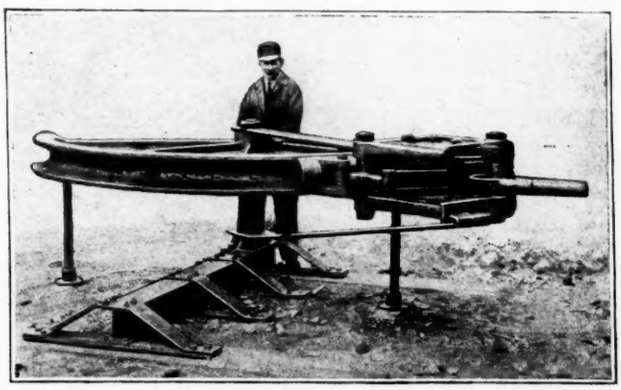
A plant operating 360 days a year, burning 40 tons per day, getting 45 instead of 70 per cent. efficiency, wastes enough to take a shipload of soldiers to France and bring the ship halfway back.

Out of the hundreds of thousands of plants in the country, if but 14,000 of the kind mentioned in the preceding paragraph would likewise better their efficiency, the 50,000,000 tons of coal we must save this year would be saved.

For the average plant good boiler efficiency is 99 per cent. a matter of care in operation.

The Wonder Pipe Bender

To bend steel, iron, brass or copper pipe without crimping or weakening is one of the difficult problems in pipefitting work. A machine that simplifies this problem is known as the Wonder pipe bender and is manufactured by the American Pipe Bending Machine Co., 37-39 Pearl St., Boston, Mass. This machine is



HERCULES PIPE BENDER FOR 4- TO 6-IN. PIPE

capable of bending to any required degree all sizes of pipe generally used, and it bends the pipe cold, either standard-gage or extra-heavy, without treating or filling of any kind. It can easily be knocked down and be moved from one job to another. It is built in five sizes, for bending pipe of every diameter from ¼ in. to 6 inches.

The model S Jr. is equipped with six heads, from ¼-in. to 1 in. Model A is equipped with seven heads, from ⅜-in. to 2-in. Model B standard is equipped with three heads to bend 2½-, 3- and 3½-in. material. Model B special is capable of handling any pipe in sizes from 1¼- to 4-in. The machine shown in the illustration is a "Model C Hercules," made for bending large pipe, either wrought-iron or steel, from 4- to 6-in. in size. The time required for making a 6-in. bend with cold pipe is less than ten minutes.

The illustration explains itself. The bender consists of a semicircular head which is supported by an upright and from which arms extend to carry the bending shoe and toggle-jointed lever. With the pipe placed between the head and the bending shoe, pressure is exerted by moving the lever shown at the extreme right, the process being continued until the proper bend has been obtained.

Waterwheel Types and Settings

By DAVID R. SHEARER

Describes various forms of waterwheels and turbines with regard to the direction of flow of the water, the position of the shaft and the casing of the wheel.

THE first type of waterwheel used, so far as is known, was the undershot, which consists of a series of paddles radially mounted and dipping into a flowing stream, as shown in Fig. 1. This wheel was very inefficient as it utilized only a part of the kinetic energy of the flowing stream and none of the pressure or weight energy.

A later development of the same wheel was in the construction of closed buckets and the application of the water at about the height of the wheel axis, as in Fig. 2. This was called the breast wheel, and it was somewhat more efficient than the undershot type since a part of the weight of the flowing water was utilized.

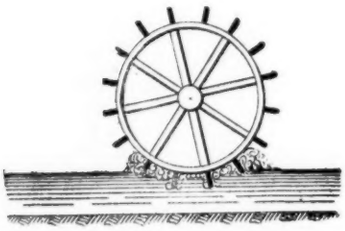


FIG. 1. UNDERSHOT WHEEL

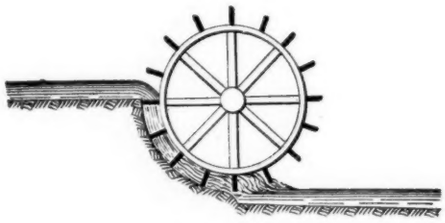


FIG. 2. BREAST WHEEL

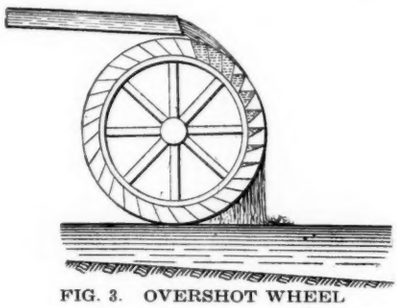


FIG. 3. OVERSHOT WHEEL

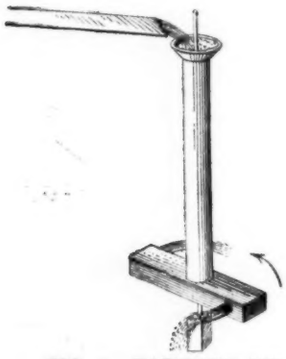
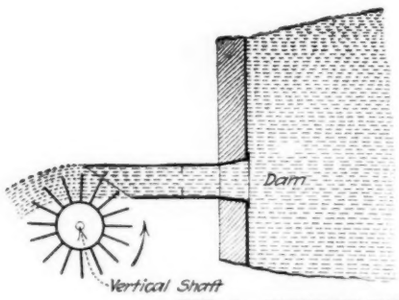


FIG 4. BARKER'S MILL



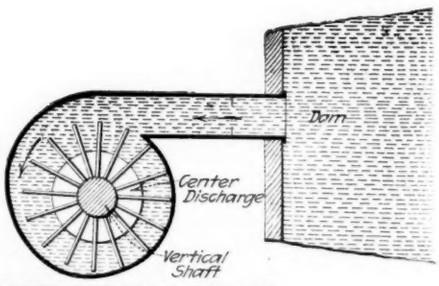


FIG. 5. IMPULSE WHEELS WITH VERTICAL SHAFTS

A further development resulted in the overshot wheel, Fig. 3, which operates chiefly from the weight of water in the buckets, although in some instances a head of water greater than the diameter of the wheel is used to add velocity to the stream operating on the buckets. The overshot, in both wood and steel construction, is still used to a considerable extent for the development of small powers and, when properly installed, is almost as efficient as a modern turbine. However, it has two inherent defects, even when it is located at a site for which it is adapted.

The overshot wheel is essentially slow-moving on account of its large diameter and must be geared up on a high ratio in order to operate machinery at a suitable speed. This gearing is inefficient and consequently wastes much of the power of the wheel in friction so that the over-all efficiency may be very low. Another disadvantage is that the overshot wheel is very difficult to govern accurately and efficiently. This becomes apparent when we consider the following two conditions:

Assume that the wheel is operating under light load, with the buckets only partly filled, and assume a heavy load to be suddenly applied to the operating machinery. The water is turned on sufficiently to carry the additional load, but before all the partly filled buckets can be filled the water must fill the top spaces, which have little turning effect; consequently, the wheel slows down and may actually stall. On the other hand, assume that the wheel is operating under full load with all the buckets full and that a great part of the load is suddenly removed. The water already in the wheel cannot be changed, even though the gates at the entrance are closed. The buckets must revolve to the bottom of the wheel to be discharged, and so the wheel speeds up until the working buckets have been emptied. To obviate this, some form of brake must be applied to hold the speed normal, resulting in a loss of efficiency.

The overshot wheel is not commonly suitable for heads below eight feet or above forty feet, on account of structural features, and is not suitable for operating machinery on which the load is variable and the speed must be kept reasonably constant, for instance, in the case of electric plants. However, this type of wheel does fill a need in cheaply developing a small power for operating mills and some kinds of wood-working machinery.

Another class of wheel, in which the operating shaft is vertical, is the Barker's mill, Fig. 4, which operates by the reaction of the water discharged from the nozzles. Although a very primitive device, it is really the forerunner of the reaction turbine.

Another of the early wheels was a vertical paddle wheel against which the water was discharged from an opening in the bottom of a dam, as shown in Fig. 5a. It is possible that this was the first real impulse wheel, from which the Pelton is a logical development. As originally constructed from wood, this form was subject to severe stresses, because the water jet struck only one paddle at a time; so an improvement was made by placing a volute wood casing around the wheel to make the water strike several of the rotating blades at the same instant and then discharge at the center of the casing, as in Fig. 5b. This type, called the center-discharge wheel, was the forerunner of the inward-flow turbine.

The real principle of the overshot wheel has never been changed and but little improvements other than structural have been made, but the Barker's mill and the center-discharge wheel were later developed through many gradual changes into the outward-flow or Fourneyron turbine and the inward-flow or Francis turbine. The former was first built in France in 1826 and the latter in the United States in 1838, and both were reaction wheels in the early types. As will be noted from Figs. 6 and 7, both were radial-flow wheels also, which means that the water did its work while flowing in a plane at right angles to the axis of the runner.

About this time another turbine was developed, called the axial-flow or Jonval wheel, in which the path of the water was parallel to the axis of the runner, as in Fig. 8.

At the present time there are really only two types of waterwheels in common use: The impulse wheel, popularly called the Pelton, and a combined development of the inward-flow and axial-flow turbines, popularly called the Francis turbine. The latter is not entirely a reaction turbine in its most highly developed form, but utilizes to some extent the pressure change in the water as it passes through the long buckets.

The impulse wheel is nearly always operated on a horizontal shaft, but the Francis runner may be used on either a horizontal or a vertical shaft. The impulse wheel, because it is operated by a jet of water striking the buckets, is necessarily covered by a casing which may have any one of several forms; but this casing is subject to no water pressure, since the water falls away from the runner at atmospheric pressure. On the other hand, the Francis runner may be set in many ways, both cased and uncased, but in every instance the wheel itself must be subject to the weight or pressure of the water head. These methods of setting are illustrated in Fig. 10.

One or more runners may be operated on the same shaft as indicated in the twin wheel, Fig. 11, which has the advantage that the thrust of one wheel along the shaft is exactly balanced by an equal and opposite thrust from the other wheel.

The mixed-flow, or Francis, turbine is operated with three forms of gates used to cut off the water from the guide vanes around the wheel. These are known as the cylinder gate, register gate and wicket gate and are illustrated in Fig. 9.

The cylinder gate is simply an open cylinder which slides down over the guide vanes. thus cutting off the water for the wheel to the amount required for proper speed and power. This gate is objectionable on account of the eddies formed at part openings with a consequent loss of efficiency.

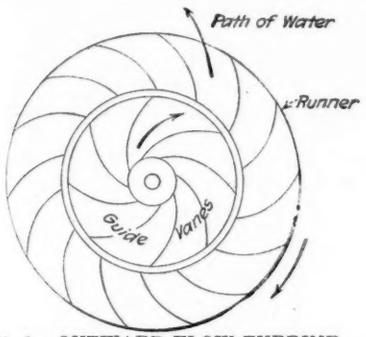


FIG. 6. OUTWARD-FLOW TURBINE

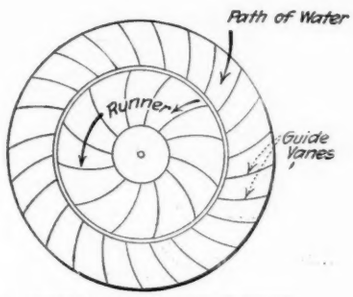


FIG. 7. INWARD-FLOW TURBINE

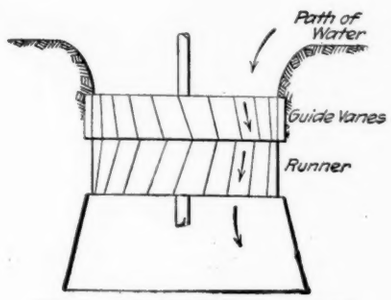


FIG. 8. AXIAL-FLOW TURBINE

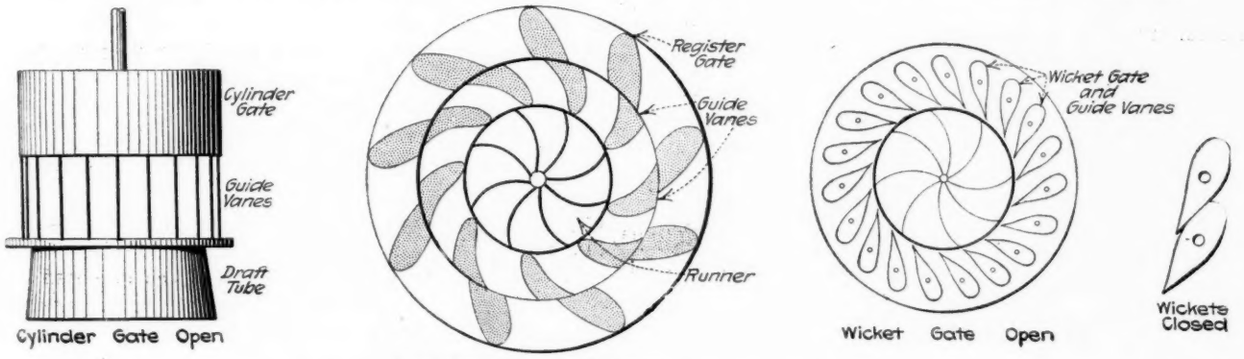


FIG. 9. TYPES OF GATES USED ON FRANCIS TURBINE

The register gate is slightly more efficient and is formed by a concentric movable ring that contains openings and that can be turned over a fixed ring also containing openings. When the openings correspond, or register, water is admitted to the wheel, but when the openings in the outer ring are moved opposite the closed spaces in the inner ring, the water is entirely cut off.

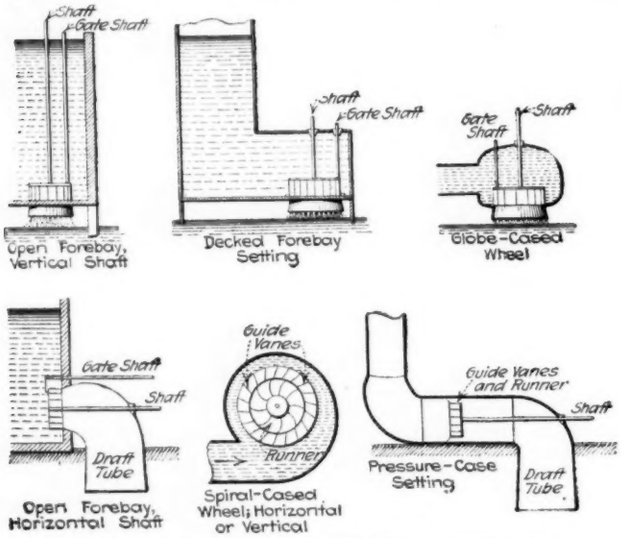


FIG. 10. METHODS OF SETTING TURBINES

The wicket gate is probably the most efficient and operates like the lattices in a window blind. Each wicket turns on a pivot, and all the wickets are linked or geared together so that they turn in unison. The wicket gates themselves form the guide vanes to the wheel, and the angle at which the water strikes the wheel varies with the load. This improves the efficiency of the wheel by preventing the formation, to some extent, of eddies at partial gate opening. Another advantage in the wicket gate is that the water pressure is practically balanced on each half of the gates, so that gate movement is comparatively easy at all loads and friction is not serious as it sometimes is in the register gate; neither is a counterbalance necessary, as is often the case with the cylinder gate.

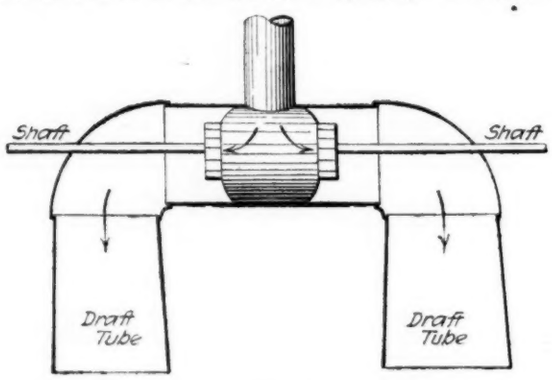


FIG. 11. TWO TURBINES ON SAME SHAFT

Many a man loses interest in his work in the fireroom when he sees that his work is never recognized, says *Marine Engineering*. A little encouragement is wise. Go down into the boiler room now and then and say a word of appreciation to the man with the shovel.

Poisonous Fumes and Vapors

By Chesla C. Sherlock

Injury from fumes and vapors is common in mining or other underground operations, but it also occurs with reasonable frequency in many other employments where it is more or less unexpected.

Engineers and others employed in the power houses of ordinary industrial concerns are frequently overcome by the fumes arising from ashes or from the furnaces themselves. It is a frequent occurrence for workmen employed on coke furnaces to become subjected to this peril.

But coal does not present the only danger to this class of workmen. Where gasoline is used as a medium for generating power, workmen are frequently overcome and even killed by coming in contact with the gases caused by the burnt gasoline.

Aside from this, the number of cases reported show that furnace gas is a common occurrence and has often caused or been the means of causing the death and injury of workmen.

Some Decisions of the Pennsylvania Courts

In a Pennsylvania case the deceased was employed upon a coke furnace, and while attempting to fix a defective spray pipe about forty feet from the ground, he was overcome with gas. It was shown that he had been given three helpers and that, one after another, they had gone up to the pipe, but had been forced to descend after a few minutes because of the escaping gas from the furnace. One employee was so badly overcome that it required 45 minutes to revive him.

The deceased then ascended the ladder and was overcome, lost his balance and fell to the ground, sustaining injuries that caused his death. It was shown that during the two years which the deceased had been employed the escape of gas from the furnace had been almost constant. A judgment in favor of the plaintiff was reversed, the court holding that the deceased had assumed the risk of the gas and that the employer could not be held. Although this case was decided in 1914, it arose under the common law, and of course common-law procedure and rules had to apply. While such a decision would not obtain under the workmen's compensation acts at the present time, the case is worth quoting because it shows the class of employments that are often affected and it also points out that at the present time the employer would be held liable if the poisonous fumes were incidental to the workman's employment as they were in this case.

In another case, decided in Pennsylvania in the same year, the plaintiff was working on the roof of a power company and noticed escaping gas near the furnaces. He complained of it several times and was several times temporarily overcome so that he had to be helped down the scaffold. At last he was overcome and fell upon a hot pipe, which severely burned him. Although he was denied recovery under the law then, he would recover for the same injury today, for the workmen's compensation cases have abolished the old rules of assumption of risk and other common-law defenses, and it makes no difference whether the action was brought under the compensation acts or not, the employer could not plead that defense now.

There is a distinction in the compensation law which must be recognized, however, applying to poisonous fumes and vapors. Compensation can be recovered only for those injuries that are caused by an "accident" arising out of and in the course of the workmen's employment. If the injury from the fumes or vapors is in the nature of an occupational disease, there can be no recovery, except in Massachusetts and those states where there is express wording of statute to that effect or the wording of the statute is so modified that it has been construed by the court to include such diseases.

Occupational or Industrial Diseases Defined

In Massachusetts the basis of recovery is not an accident, but a personal injury, and the courts have said that an occupational disease caused by poisonous fumes and vapors is a personal injury, as it undoubtedly is. But in the majority of the states the injury from fumes and vapors must be in the nature of an occupational or industrial disease if compensation is to be recovered. It is necessary, then, to ascertain what is meant by the expression "occupational disease" in order to determine just what the liability of the employer in this respect really is.

In a New York case the court set out a definition of an occupational disease, which fairly states the matter:

> An accidental injury . . . is clearly distinguishable from an injury in the nature of a vocational disease, sustained in the course of the employment, where, from the inherent nature of the work, disease is likely to be contracted.

"Corpus Juris," a recognized authority, states that an occupational or industrial disease is a disease caused by or especially incident to, a particular employment. In occupations where these diseases are reasonably certain to occur if the workman persists in his employment for a certain period of time, then the employer cannot be held for compensation when the disease does assail and incapacitate the workman.

Lead and copper poisoning are fair samples of occupational diseases. They occur in certain employments, and the fact that they will occur is practically certain provided the workman follows the employment long enough.

But in the case of workmen being overcome from fumes and gases generated by furnaces, the nature of the injury is not as an occupational disease, but more as an accident. It is not the rule in this case, but the unusual, the unforeseen, the unexpected event, and is clearly of an accidental nature. Such cases, arising in the manner indicated, would be compensable, and the employers would be called upon to so provide for the injured workmen or their dependents.

Draft Tubes of Turbine Waterwheels

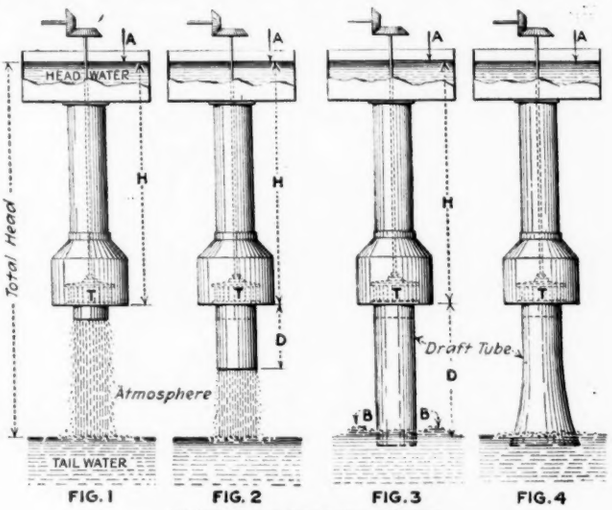
The effective pressure acting on the buckets of a turbine waterwheel is the initial pressure minus the back pressure, and the purpose of a draft tube is to increase the value of the effective pressure by removal of back pressure.

Figs. 1, 2, 3 and 4 represent turbines, each acted upon by the head of water H plus atmospheric pressure A exerted on the surface of the water in the penstock. The initial pressure in each case may be considered as the pressure due to the head H plus atmospheric pressure A.

In the case illustrated by Fig. 1, after the water passes through the turbine T it is discharged directly to the atmosphere and cannot escape without overcoming the reaction of atmospheric pressure. In this case the full pressure of the atmosphere exerts back pressure and the effective pressure is the pressure due to the head H plus the pressure of the atmosphere, minus the pressure of the atmosphere.

Action and reaction of atmospheric pressure are equal, and the effective pressure is simply the pressure derived from the head H.

In the case illustrated by Fig. 2, all conditions are the same as those illustrated by Fig. 1, excepting that a short draft tube of length D has been added. The back pressure on the turbine in this case will not be equal to the pressure of the atmosphere because part of the reacting atmospheric pressure is employed in overcoming the pressure due to the head D. Hence, if the draft tube is completely filled with water, the effective pressure must be derived from the head $H + D$. As



FORMS OF DRAFT TUBES

the reaction of atmospheric pressure may be overcome by a column of water about 34 ft. high, greater drop of draft tube could be of no advantage and would be a waste of the total head available. In fact, when the draft-tube column of water is more than about 30 ft., the pressure is so reduced that air liberated out of the water or leaking into the turbine may seriously interfere with its proper performance.

By extending the draft tube from the turbine to the tail water, as indicated in Figs. 3 and 4, the total head may be utilized, provided the turbine is set so low that no greater height of draft tube is required than may be necessary for the draft-tube column of water to overcome the pressure of the atmosphere. To better insure against admission of air, the discharge end of the draft tube should be sealed by extending the tube below the surface of the tail water, as indicated by the dotted lines in Figs. 3 and 4; and to obviate reaction by loss of head from lumping up of the tail water as indicated at BB, Fig. 3, the lower end of the draft tube should be enlarged as shown in Fig. 4, so the water discharged may be brought to rest by a gradual reduction of its velocity.

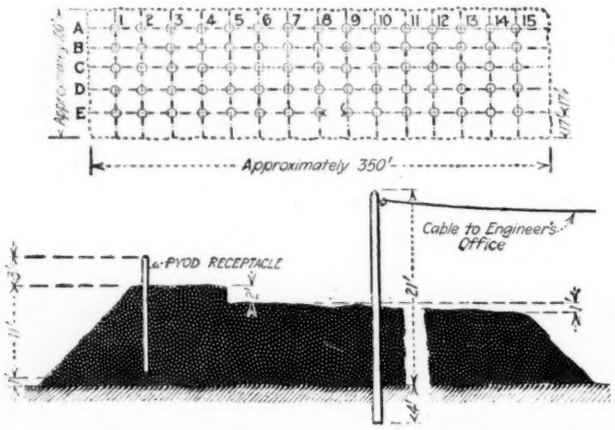
Checking Stored-Coal Temperatures Electrically*

By THOMAS W. POPPE

Effective method of detecting incipient fires in piles of stored coal by means of electrical thermometer. Coal must be stored and conserved from unnecessary waste.

IT IS necessary at this time for power plants to store coal. The economical operation of the railroads requires it, and such procedure is necessary in anticipation of serious delays in coal delivery during the winter period. The experience of the writer, who was charged with the responsibility of storing 10,000 tons of bituminous coal and protecting it against fire, may be of value.

The greatest danger connected with storing coal is in the slow combustion which takes place and is not detected until the odor of sulphuric fumes becomes noticeable. When this action begins, the coal should be redistributed so that the pressure existing on the heating layer is removed. In some cases the entire coal pile would have to be turned over, since the greatest pressure is on the bottom, thus requiring quick action and the expenditure of a large sum of money. Any scheme whereby an increase of temperature in the coal



PLAN SHOWING SPACING OF PYOD RECEPTACLES—ABOVE. SECTIONAL ELEVATION OF COAL PILE WITH TEMPERATURE MEASUREMENT APPARATUS IN PLACE

pile can be detected or by which it can be retarded or prevented will therefore be a saving. To accomplish the first objective where the writer is engaged, an electrical thermometer system was installed with the temperature-indicating instrument, or pyrometer, in the engineer's office. Switches were so arranged that the temperature of predetermined locations in the coal pile could be obtained almost instantly. The second objective was obtained by reducing the pressure on the heated layer, removing all the coal at that particular point if necessary. A temperature of 250 deg. F. (120 deg. C.) was assumed to be the safe internal temperature; if the pyrometer showed a close approach to this figure, the coal at this point was immediately removed to the point nearest the place of consumption. This involved little additional expense in operating costs, as the coal would eventually find its way there anyway. This is not true of the "turn-the-coal-over" method, especially if the storage place is limited.

To keep within the safe temperature limits, the coal, as consumed, was removed from the top in two-foot layers with a gradual slope toward the point of consumption. The removal of the two feet of coal reduced the lowest layer from the pressure of the removed weight, and the gradual slope made the work of the men with loaded wheelbarrows less than if a perfect level was retained. One advantage of the removal of the top layer was that additional shipments received could be methodically added and the good and poor qualities automatically mixed, maintaining a fair average.

Ten thousand tons of coal piled 12 ft. high meant that a ground area of 33,350 sq.ft. would be required, assuming a value of 50 lb. per cu.ft. A trackage of 400 ft. permitted the unloading of coal on a plot 350 x 100 feet.

For satisfactory detection of heat changes in the coal to be stored on this plot it was decided to place pyod receptacles (thermocouples) spaced as shown in the illustration. The receptacles were constructed of 1-in. wrought-iron pipe welded to a point at the end which entered the coal pile. The exposed end was fitted with a self-closing cap to prevent the entrance of any substance which might interfere with the ready insertion of the pyods. Fifteen pyods were purchased. These were portable. The wiring to the engineer's office, however, was of a permanent nature from a central location on the coal pile. From this point lines radiated to the portable pyods. The general arrangement is shown in the illustration.

The pyod receptacles were numbered 1 to 15 on each row, which had a distinguishing letter as shown in the illustration. The switches in the engineer's office were numbered and lettered in a manner to correspond with the pyod receptacles. This plan permitted an attendant to place the pyods in the desired receptacles and the engineer to observe and record in the station log, in numerical order, the temperature readings of the coal at the different points. After placing the last of the pyods in row *A*, the attendant immediately commenced transferring them to row *B* in numerical sequence. The time elapsing between the insertion of the first and the fifteenth pyod was considered sufficient for the pyod to adjust itself to the various temperatures encountered, inasmuch as the temperature to be measured already existed in the pockets formed by the pyod receptacles. Thus an unbroken operation can be carried out in the shortest possible period of time. After the temperature existing in the last pyod receptacle was read, all the pyods were transferred to centrally located receptacles, as it was assumed that this would be in the vicinity of the greatest possible heat generation, inasmuch as they are the farthest removed from the cooling effect of the air.

If desired, a recording pyrometer can be installed in conjunction with the indicating instrument, thus providing for permanent records.

*From *Electrical World*.

EDITORIALS

Relieving Boiler Attendants of Feed-water Regulation

THE task of the Fuel Administration is principally to save fuel, but unfortunately most of us accept this isolated function as its principal reason for being, little regarding the broader aspect and never for a moment linking it up with other agencies in the big problem of winning the war. Perhaps the fault is due to the Government's methods and to the competition of various Government agencies for public attention. Each agency advertises that its particular object is to win the war, and this is evidenced, for instance, by the slogan of the Food Administration, "Food will win the war." We are told that our shops and factories will win the war, that ships will win the war, and that man power will tell in the end.

Actually, each agency of itself will not win the war, and we shall not meet the Fuel Administration fully, although we may technically, unless we consider all the factors that contribute toward making our weight felt in Europe. We must not only save coal, but we must save labor and must keep our plants running to capacity without breakdown. It serves our country little if to save fuel we employ more labor than the saving is worth and neglect maintenance and operation so that a shutdown becomes necessary. Nor should we suddenly decide to install expensive apparatus which diverts industry from direct war production to capital construction.

The problem of the Fuel Administration is to save fuel, to save labor, to increase capacity and insure continuity of operation and to eliminate the installation of costly apparatus and construction. The fuel problem and the labor problem are practically one. At least five per cent., or roughly thirty million tons, of the coal shipped in 1917 was dirt and stone, and it is estimated that the heat value of coal as shipped in 1917 was nine per cent. less than in 1916. The grade of coal, moreover, is constantly changing, so that taking it all in all, our fuel situation means principally intelligent and personal attention to combustion, and as intelligence is a human function this means a greater reliance on the human individual.

The labor situation unfortunately offers no easy remedy, as it is most acute. The labor turnover in the United States at present is four hundred per cent. Recently, the Pennsylvania Railroad Lines West reported that eighty-four thousand men were taken on in eight months to fill two thousand jobs, the labor turnover running as high as seven hundred per cent. per week. The Government has found it easier to raise money than to exchange this money for war commodities, mainly because of decreased production due to the labor situation. With an increased army and from eight to ten men here to supply every man in France, we can look forward to less help in the boiler room rather than more or even as much as we have now.

We shall have to increase the capacity of our present boiler equipment, as new boilers cannot be had and time presses. Operation must be continuous, as each shutdown more than wipes out previous economies and production. We need our production for direct war work, and we cannot ask for more equipment as the Fuel Administration wants us to make the best use of what we have. Our chief reliance must be the human individual, as to him we must look for better combustion and the carrying out of all the other suggestions of the Fuel Administration. More and more it is being realized that our wealth is represented by the collective intelligence of our population rather than by our natural resources; otherwise, China and India would be more powerful factors in the world than the United States.

It would seem, therefore, that our first problem is to relieve the boiler-room force of all automatic and machine-like functions, particularly those that require constant vigilance and therefore cause worry and that are at best poorly performed manually, thus releasing men for concentration on problems requiring intelligence, such as combustion, gas analysis, proper maintenance, etc.

Of the several things that come to mind in the boiler room, no function is less adapted to manual regulation and more adapted to machine regulation than feeding water to a boiler. It is purely an automatic function, governed only by operating conditions and not complicated by any change in the nature of the material fed, as water always remains homogeneous. Automatic regulation seems strange mainly because we are used to water tenders and have not become accustomed to thinking of it as a machine function.

Only two conditions are imposed on good regulation; namely, proper maintenance of the water level between certain fixed points and continuous feeding of water in proportion to the load on the boiler. Both of these lend themselves readily to machine control, as is brought out in the letter on page 678 of this issue. And it must be evident that any scheme or device whereby the boiler-room force may be relieved of the necessity and the tedium of watching the water level and regulating it by hand must furnish additional time for the performance of the numerous duties that cannot be done automatically.

Saving Coal in the Boiler Room

TWO views may be taken regarding the conservation of fuel in the boiler plant. One is that of reducing the cost of the fuel consumed; the other is that of reducing the weight of fuel burned—two vastly different propositions.

One of the main objects of fuel conservation is to relieve the transportation systems of unnecessary tonnage. The primary object is not to save in the cost of coal, although many may think to the contrary, but to

decrease the weight of coal consumed. For instance, the engineer who one year ago used coal high in heat units and paid a high price may now be burning a mixture of bituminous coal and anthracite screenings. This mixture, costing less than the high-grade bituminous coal used one year ago, requires an additional tonnage of about twenty per cent. for the same power production, although the engineer is saving in the heating units expended. It is not what amount of money can be saved, but how much the tonnage can be cut down that counts at present.

It should not be so, but there are men in charge of steam plants who do not know how to reduce their coal consumption. They do not know or, if they do, they do not put their knowledge into practice, that a low rate of combustion per square foot of grate surface means waste. As a sample of improper operation, three boilers may be used, each running at a low rating, whereas two boilers would be sufficient to carry the load with a high rate of combustion being maintained in the furnaces.

Frequently, there is but one boiler in the plant, and of larger capacity than is required, and the grate area is of such proportions that not more than ten pounds of bituminous coal are burned per square foot of grate surface per hour. Removing the boiler and installing a smaller one would be out of the question save under exceptional conditions. The engineer can, however, reduce grate area so that the fuel consumption will be between fifteen and twenty pounds of soft coal per hour per square foot of active grate area. This will increase the rate of combustion, which is necessary for higher economy.

Such a change may not be agreeable to the fireman. It does not permit him to fire a large quantity of fuel into a furnace with long intervals between firing. Under the latter condition the furnace is cooled and the combustible gases that are liberated from the freshly fired coal escape to the chimney unburned. The reduced grate area will require more frequent firing, with the result that the furnace temperature is kept higher and the liberated fuel gases are consumed in the combustion chamber. The result is higher furnace temperature and better boiler operation in every way.

Naturally, a change in grate area brings about a necessary change in damper operation and control. Every boiler furnace should be equipped with some type of draft gage. It will do away with guesswork and will insure the proper amount of air for the combustion of the fuel. If the fireman has been in the habit of keeping the damper wide open and kicking the ashpit doors closed and open, in his effort to control the steam pressure, see that his method is changed and that the draft is controlled by the damper only.

It is the duty of every engineer to supervise personally all matters connected with the operation of his boilers. It cannot be expected that a fireman is going to be greatly concerned with the boiler performance if the engineer apparently does not give it any attention.

Frequently, firemen oppose any and all changes because they labor under the impression that something is to be installed that will be against their interest. Under such conditions the personal supervision of the boiler-room operation by the engineer is essential if his orders are to be carried out. The proper thing to do would be to get rid of such men who will not coöperate, but under the existing conditions, with the extreme shortage of good firemen, the engineer is obliged to put up with inferior work and get the desired results as best he may. This is also an incentive for the personal supervision of the boiler-room force by the engineer in charge.

"The War's Over" Folly

ANY tendency to slow up war work, in whatever branch, should be stopped immediately, both by voluntary and by official action, in industries upon which our fighting forces are dependent. It is amazing that so many intelligent persons fall for the tricky peace talk of the enemy and relax their efforts in the ill-considered belief that hostilities are about over.

It is true that the war may end suddenly and that victory at last seems assured to the Allies; but the date of triumph no man can fix, and unless everyone keeps at his work with heart and soul, striving to help in all possible ways as though the end were years distant, the cost in life and in material resources will be all the heavier.

If the Huns decide to fight to the last ditch, a glance at the map should be sufficient to show what a long and hard struggle may lie ahead. Every engineer therefore owes it to the great cause of liberty to keep at it harder than ever in trying to supply the needed power at the lowest cost consistent with reliable service, to go on working overtime cheerfully, to maintain the keenest scrutiny of equipment and to watch for fuel waste and preventable losses as never before.

Let the War Savings and Thrift Stamp campaigns be waged with renewed vigor, let each one do his best to help in the coming Red Cross and other welfare drives, and let no intelligent engineer be found among those who have too soon let their understanding of the real situation be cotton-wooled by the crop of Teutonic peace thistles which the Kaiser is trying so hard to raise to our lasting discredit as a clear-sighted and aroused republic!

Save Condenser Tubes

THE condition with regard to condenser tubes is serious. Copper and all the yellow metals are scarce, and the fitting out of the multitude of vessels which are being built to replace those sunk by the enemy calls for an exceptional number of surface condensers.

To provide tubes for these and for the largely increased Navy, the Government lays first claim upon all the condenser tubes available, and there will be at best a very small supply of such tubes procurable for repairs on land condensers. No new surface condensers are obtainable for stationary work, and it behooves those in responsible charge of existing plants to conserve condenser tubes in every conceivable way.

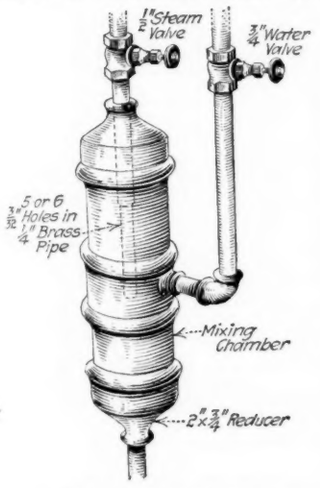
Among the ruins of Belgium and France none has been made more complete by the Hun than power plants, for he recognizes these to be the prime movers of industry, and with these gone his enemies are handicapped in the commercial struggle that will follow peace. But why not put these plants in service by installing equipment taken from German plants? Why not exact this as one of the Allies' peace conditions?

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellow-engineers how you have saved coal. "Power" will pay for good articles that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

Instantaneous Water Heater

I have devised a simple method of heating water somewhat similar to that described by Mr. Orr in the issue of Sept. 24, page 465. My device has been in use for several years and has proved entirely satisfactory. It obviates annoying water-hammer and spasmodic flow, which is associated with most direct-connected pipe arrangements. The mixing chamber prevents water-hammer and permits a wide range in temperature. The heater, or mixing chamber, can be made of any convenient fittings, bushings and couplings, tapped caps or reducers, but the latter make a better-looking job. The illustration shows how my heater is made and that it is in a vertical position, but there is no reason why it will not work in a horizontal position as well.



STEAM WATER-HEATER

Long Island City. WILLIAM WEIDMAN.

Diagnosis of Indicator Diagrams

Diagnosing the indicator diagrams in the issue of Oct. 15, page 572, sent in by Mr. Robertson, it is quite evident that steam is leaking into the receiver. This leak could occur only through the exhaust valves or the piston, and it is so uniform that the chances are that it is through the piston. The expansion lines of Fig. 1 show a heavy leak to half-stroke where they arrive at the receiver pressure, and as the low side is just beginning to take steam at that point there is gradual drop in the receiver pressure until the end of the high-pressure stroke, which point also marks the point of cutoff on the low, as indicated by the rise in the exhaust lines of the diagram.

Such a card, making these loops, would be produced if the indicator was attached directly to the receiver. The remarkably good feature of Fig. 1 is the way the steam lines are maintained, which shows that the steam-supply pipe is of sufficient size and it is likely that there is a good-sized receiver near the cylinder.

The condition of the valve setting as shown by Fig. 2 is poor and will be greatly improved by reducing the compression on the head end and adjusting both exhaust valves to open earlier so as to do away with the excessive back pressure shown during the early part of the exhaust stroke. In addition to this the cutoff should also be equalized. J. M. COLEMAN.

Somerville, Mass.

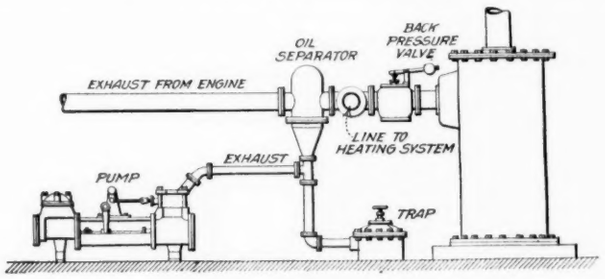
Regarding the two indicator diagrams shown on page 572 in the issue of Oct. 15, I judge that Fig. 1 was taken when the high-pressure exhaust eccentric was too far back, causing late release and low compression. It shows that the steam expanded down to a certain point and then, as the piston returned part way before the exhaust valve opened, the back pressure in the cylinder increased until release finally occurred. This accounts for the loop.

The engine was evidently developing more power when the diagram shown in Fig. 2 was taken, as cutoff is considerably later, while the receiver pressure is about the same. F. P. STODDART.

Burlington, Iowa.

The Piping Layout Was Bungled

The illustration shows the piping layout of a certain steam plant in which an oil separator is placed in the exhaust pipe from the steam engine and between it and the outlet to the heating system back-pressure valves



PIPING OF PUMP TO TRAP

and heater. The separator is drained by a trap as shown. As may be seen, the exhaust pipe from the boiler-feed pump is connected to the drain pipe between the separator and the trap.

Most engineers will agree that any man who will pipe the exhaust from a boiler-feed pump into the drain of an oil separator should not disgrace other engineers by calling himself one. LOUIS ALLEN.

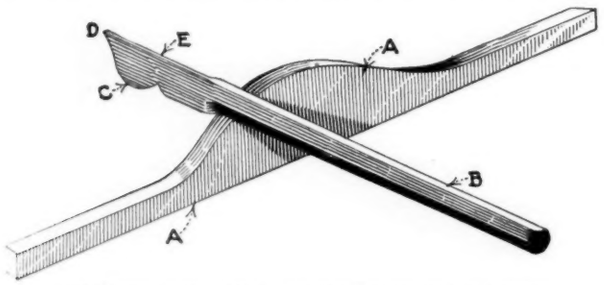
Johnson City, N. Y.

Tool for Undercutting Mica

The tools for undercutting mica shown and described on pages 174 and 500 in the issues of July 30 and Oct. 1 suggest that a description of the outfit I have frequently used with excellent results may be of interest.

In the illustration *A* represents a steel straight-edge about ¼ in. thick and slightly longer than the length of the commutator segments and square at one end to butt up against the head of the commutator. *B* is the undercutting tool, about 12 in. long, made from a piece of $\frac{5}{16}$ hex. tool steel forged flat for about one-fourth of its length to a thickness at point *D* equal to the thickness of the mica between the segments. The "half-heart" shaped lobe *C* affords a bearing place for the fingers in using the tool.

Lay the straight-edge on the commutator with its edge in line with the mica between the segments with the square end against the head of the commutator and hold it firmly with the left hand. Then, holding tool *B* in the right hand, draw the point *D* along the mica the same as drawing a pencil along a ruler in ruling paper. This operation will start a nice groove in the mica without burring the edges of the copper on either side. After one or two passes the tool can be turned endwise



COMMUTATOR MICA UNDERCUTTING OUTFIT

with point *D* down and the mica taken to any desired depth or a saw blade may be used, as suggested in previous issues, to finish the groove. The disadvantage of the saw blade is that the set of the teeth burr the copper more or less, while with this tool all chance of a burr is eliminated.

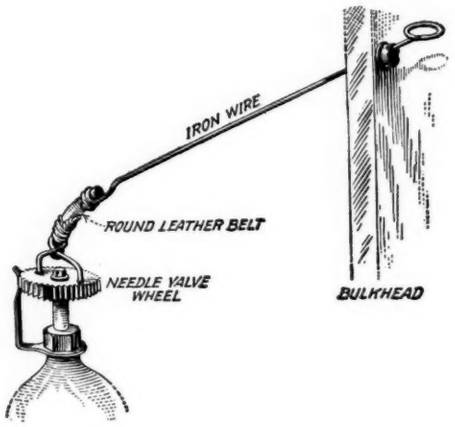
The tool will also be found handy in raising coil leads out of the slots in the head of a commutator when unsoldering them preparatory to removing the commutator or making coil repairs. After heating the ends of the coils until the solder starts to melt, drive the point of the tool into the slot under the ends of the wires, with lobe *C* down, for a fulcrum, on the bottom of the slot, and the ends of the coils can be easily raised by a downward pressure of the hand. Square edge *E* can be used as a scraper for taking the surplus hot solder off the ends of the wires as they are raised.

Canton, Ohio. T. M. STERLING.

Extension for Valve Stem

The illustration shows a "universal joint" that I made a few weeks ago for use in connection with a bulkhead control for the carburetor of my motor boat. It works well, has a neat appearance and can be employed in many places about an engine room.

I first drilled two small holes in the handwheel of the carburetor needle valve and through these passed some fairly stiff wire, which was then twisted around one end of a piece of round leather (sewing machine) belt about 2 in. long to the upper end of which is fastened a piece of galvanized-iron wire which runs back through the bulkhead and has the projecting end



FLEXIBLE EXTENSION STEM FOR SMALL VALVE

bent in the form of a handle. This device will not work where a great amount of force is necessary unless the leather belt is quite large, but for anything like a needle valve it works well. HUGH G. BOUTELL.

Washington, D. C.

Mechanical Control of Boiler-Feed Water

In the June 25 issue of *Power*, page 915, Mr. Philo covers the feed-water regulation problem very carefully. His statement of the case is excellent, but unfortunately does not contain examples that would illustrate his points. He says that "variable feed-water injection with a steady load is disastrous to uniform steam pressure. Variable steam pressure, in turn, causes juggling

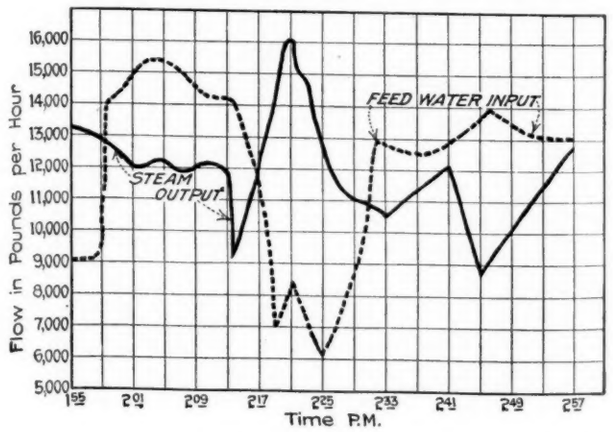


FIG. 1. EFFECT OF FEED VARIATION ON STEAM OUTPUT

of fires and short periods of loafing with consequent loss in efficiency of boilers and auxiliaries."

Fig. 1 shows this relation except that in place of steam pressure we have steam flow. The curves represent actual meter readings, taken simultaneously, of the feed-water input and the steam output of a 240-hp. boiler. It accurately represents the effect of hand regulation of boiler-feed water without the knowledge of the steam output. Instantaneous values of steam output

were taken by an indicating steam-flow meter and the water input by another flow meter. The boiler was one of a battery and the attendant had no knowledge that his work was being observed. The steam demanded of the battery was practically constant. This curve illustrates very clearly the effect of the feed-water variation upon steam output and indicates a degree of interference between boilers.

It will be obvious from these curves that, the load demand being steady, the individual output of this boiler was decreased by large injections of cold water. When

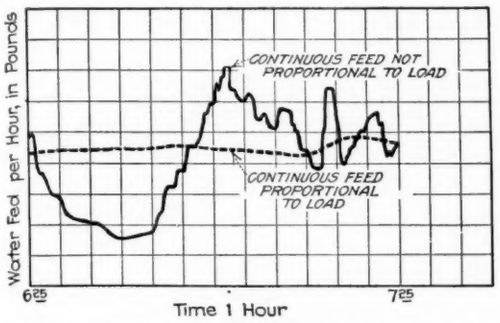

Water Fed per Hour, in Pounds
CONTINUOUS FEED NOT PROPORTIONAL TO LOAD
CONTINUOUS FEED PROPORTIONAL TO LOAD
6 25
7 25
Time 1 Hour

FIG. 2. EFFECT OF DIFFERENT METHODS OF CONTINUOUS FEEDING

the feed was shut off, the boiler capacity was increased until in all probability the excess capacity shown by the peak was dissipated through the safety valve. It is also no doubt true that steam pressure was maintained by jockeying all the fires just as Mr. Philo states, although it is much easier to control fluctuation by regulating the water feed than by jockeying the furnace. Note the loss at low capacity due to forcing the fires to keep up the pressure and the loss through

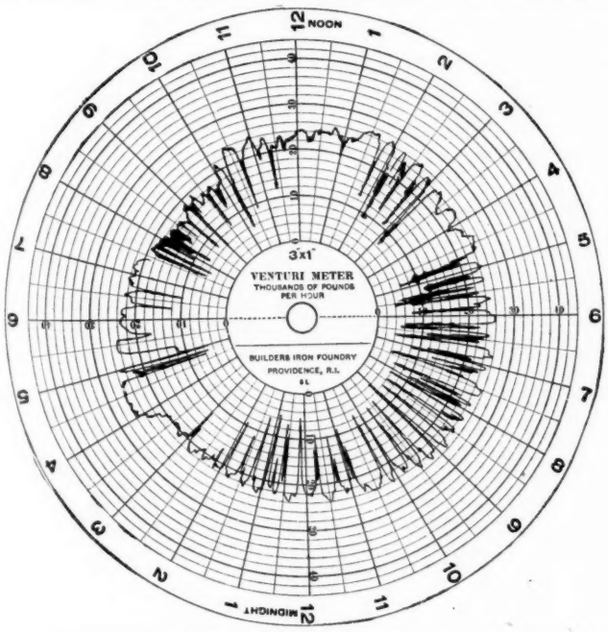


FIG. 3. INTERMITTENT FEEDING PROPORTIONAL TO LOAD

the safety valve at the peak. It will be seen that in this case the feed is continuous, but is not proportional to the load at any instant.

Feed regulation may be proportional over a period of time and may be continuous and yet give the same effect as shown in Fig. 1. Fig. 2 illustrates this point. The load on the boilers is practically uniform. In one case the feed is continuous and proportional to the load at any instant, in the other case the feed is continuous and roughly proportional to the load over an hour period. In the latter case the feeding was very light for the first half-hour, but during the

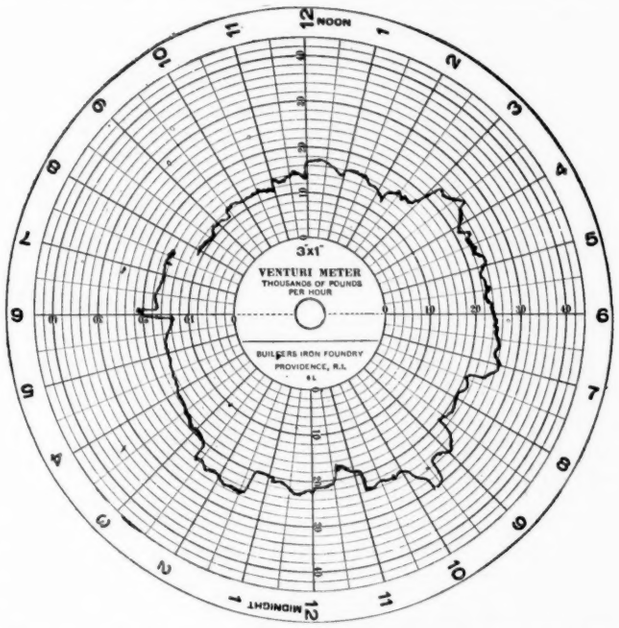


FIG. 4. CONTINUOUS FEEDING PROPORTIONAL TO LOAD

second half-hour the rate of feed was almost double, so as to make up for the excess evaporation during the first half-hour. The quantity of water fed per hour in both cases was about the same, but in the one case feeding has been smooth and even and in the other case the feed has upset operating conditions of the boiler and furnace, just as illustrated by Fig. 1.

Mr. Philo goes on to say: "However, with loads

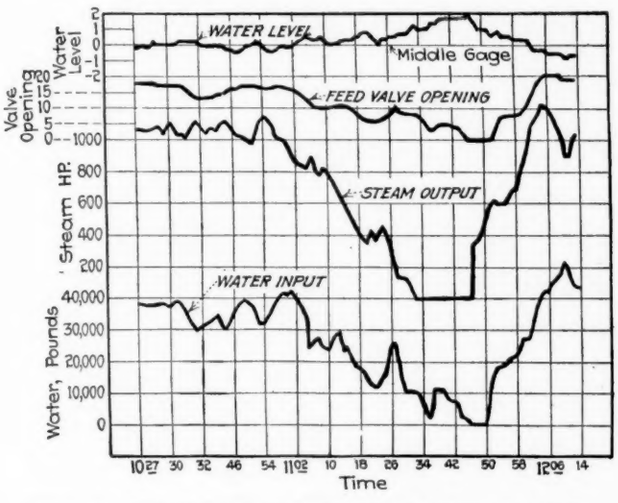


FIG. 5. HEAT-STORAGE EFFECT OF FEED WATER

that have a periodic fluctuation, as in rolling mills, variable feed-water injection, if properly handled, aids the maintenance of the steam pressure." Fig. 3 shows intermittent feed to a group consisting of a large number of boilers in a large steel mill. The feed is proportional to the load and is intermittent in character.

After the introduction of continuous feed regulation proportional to the load, the chart shown in Fig. 4 was obtained. The feed shown in Fig. 4 is variable, but is proportional to the load and continuous in character.

Quoting again from Mr. Philo in regard to what he terms the "condenser action": "When the load is high the feed is decreased, and as the load drops the feed is increased, utilizing the heat absorbed by the boiler

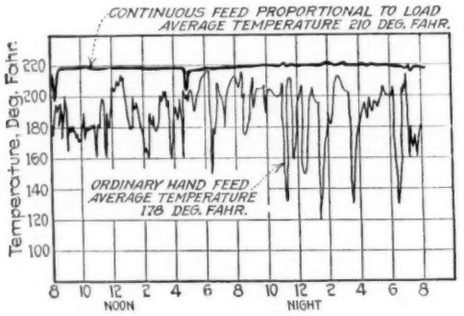


FIG. 6. FEED-WATER TEMPERATURE AFFECTED BY METHOD OF FEEDING

and admitting of fairly constant furnace conditions. This condenser action or heat-storage effect of the feed water is quite appreciable." Fig. 5 shows that this action can be obtained with mechanical feed regulation. As the load falls off, the water level builds up although the water input falls with the load. At 11:32, when the load is entirely off, the regulator still feeds until about 11:46, when the regulator has filled the boiler and shuts off. At 11:46 the load is suddenly thrown on, but the regulator does not open until 11:51, when the water level in the boiler has been dropped by using the water stored between 11 and 11:46. At 11:51 the regulator opens, feeding continuously in proportion to the load.

Mr. Philo continues: "The matter of correct boiler feeding in the majority of cases is not given the attention it deserves, as the results of improved methods of boiler feeding are felt in the operation of the whole station as well as in the size of the coal pile." The influence of low steam pressure and low capacity on plant operation is very well known. A more immediate effect on operation and on the coal pile is the temperature of the steam leaving the feed-water heater before entering the boiler. If the feeding is heavy, more cold water will be drawn through the heater than there will be steam to heat it. Conversely, if the feeding is very light during the heavy-load period, there will be too little water and a large part of the heat in the exhaust steam will be wasted. Fig. 6 illustrates this. With continuous proportional feed the amount of water is adjusted to the exhaust steam. On the other hand, with hand feeding there is no such relation, with the result that the feed water is about 32 deg. colder. As about 10 deg. rise in feed-water temperature means a saving of 1 per cent., there is in this particular case a saving of over 3 per cent. in fuel.

A dependable regulator will eliminate the worry of watching the glass and feeding the boiler, particularly where green men are employed. It will also make unnecessary the extravagant practice of filling up the boiler and then blowing off the excess water through the blowoff valve. When the Detroit Edison Co. installed their first 24 regulators at Delray, at a total cost of $1920, the services of six water tenders at $90 per month each were dispensed with. In a small plant in the South, installation of six regulators at a cost of $480 made it possible to release the water tender so that he could be assigned to flue-gas analysis and other duties.

The saving in fuel, boiler capacity, labor and insurance against shutdown more than justifies mechanical regulation. As already stated, it is purely a mechanical function more efficiently performed by a machine than by hand, and the installation cost is low, running from $75 to $150 per boiler. It conforms to the instructions of the Government as to fuel, labor and first cost. As Mr. Philo says in closing his article: "The Fuel Administration points out the serious fuel shortage; careful feeding of water to boilers has its share in making up for this shortage of eighty million tons."

Erie, Penn. E. W. NICK.

Care of Sight-Feed Lubricator

To prevent cylinder oil from adhering to and following up the side of a sight-feed lubricator glass, temporarily at least, close off and drain the glass, then swab it out with a soft rag saturated with either kerosene or gasoline. After the glass is clean, refill it with tepid solution of salt water—tepid water will avoid cracking the glass, which is likely to occur if cold water is used. It will be found on starting the lubricator that a good sized drop shoots straight up the center of the glass. The salt water is more dense than the ordinary condensate in the glass and will assist in floating the oil. Poor cylinder oil will sometimes cause the lubricator to work bad, but as a rule there is something wrong with the condition of the lubricator or its connections. The combined weight of the oil and the column of water in the condensing pipe plus the steam pressure upon it must be greater than the steam pressure on the sight-feed nozzle.

It would be of great assistance to engineers if the makers of double-connection sight-feed lubricators would include on their instruction cards the approximate height or length of condensing pipe necessary for the proper working of the lubricator. Too short a pipe is "no good" because it does not afford sufficient hydrostatic head, while too long a pipe will often allow the water to get too cold and chill the lubricator so it won't feed at all. T. M. STERLING.

Canton, Ohio.

Bolts in Crank Bearing Wedges

In putting bolts in crank-bearing wedges, don't let the threads fit too tightly in the wedge because the bolts sometimes break off in the wedge or so close to it that you can't get a hold with a wrench. If the bolt is not too tight a fit in the wedge, it is an easy matter to take the broken piece out. With a chisel cut a little groove in the top of the bolt, then with a screwdriver unscrew the broken part. I have taken out a broken bolt, put in a new one and had the engine at work in fifteen minutes. If the bolt fits too tightly, it means a long job to drill the broken part out, keeping the engine out of service perhaps for several hours. R. A. WILLIAMS.

Manassas, Va.

INQUIRIES OF GENERAL INTEREST

To Reduce Cutting of Corliss Valves and Seats—How can cutting of the seats of Corliss steam valves from wiredrawing of steam be prevented? H. F.

Cutting of the valves and seats from wiredrawing of the steam cannot be entirely prevented, but it will be much less if the engine is supplied with steam passed through a separator and also by obtaining quick action of the releasing gear and dashpots for closing the valves promptly.

Superheated Steam More Beneficial to Simple Engines—Why is more benefit derived from the use of superheated steam in a simple engine than in a compound engine? C. R.

In a simple engine the range of temperatures is broader and there is more loss of heat from cylinder condensation and reëvaporation, and therefore relatively greater benefit is to be derived from the use of superheated steam than in a compound engine.

Cutting of Valves and Seats—What causes the seats and disks of globe valves to become worn more when used partly open than when used full wide open? T. B. N.

The abrasive action of the steam is greater the higher the velocity, and in cases where partly closing the valve results in reduction of pressure on the discharge side of the valve, the higher velocity of flow due to the greater difference of pressure results in greater cutting of the valve and seat. But for the same initial and same drop of pressure, the abrasive action is no greater for a valve cracked off the seat than for one that is wider open, because the steam sweeps over the surfaces with the same velocity in each instance.

Steam Jet for Forced vs. Induced Draft—For coal burning, is a steam-jet blower more beneficial when placed in the ashpit of a boiler furnace or when placed in the stack? B. R.

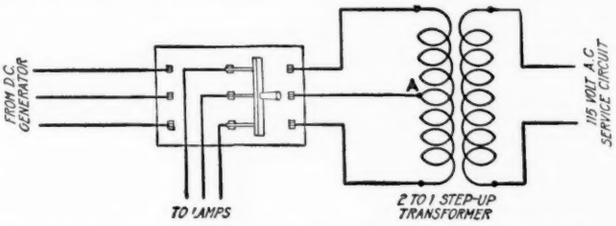
Greater advantage is generally obtained from placing a steam-jet blower in the ashpit, as in addition to increasing the draft pressure the discharge of steam opens the fuel bed and reduces the formation of clinker, and the introduction of moisture is conducive to ignition of a larger proportion of the combustible elements of the fuel. A steam jet placed in the stack can do nothing more than increase the draft and is less effective unless supplied with much more steam and at considerably higher pressure than necessary to be discharged into the ashpit. Unless used with a petticoat pipe that has been skillfully designed and placed, the draft effect is feeble, while flaring inlets for gathering the stack gases are obstructive of flue area that may be required at times when steam is not available.

Better Fuel Economy from More Frequent Stoking—During mid-winter good service cannot be obtained from a sectional boiler that is used for steam heating several apartments, unless firing is performed hourly. The present grate is 28 x 56 in. Would it not be more economical in fuel as well as require less attention to increase the size of grate to 56 x 56 in. and cover the grate with enough coal to last six to eight hours? W. B. C.

The highest fuel economy and boiler efficiency are obtained when there is rapid combustion of the fuel and when the fuel is added no faster than required. The best results would be attained by continuous stoking provided it could be performed without admission of undue quantity of cold air through the fire-door. Having the grates covered with enough coal to last for six to eight hours would result in less perfect combustion and more coal would be required for a season, although with the larger grate area the saving of the fireman's time in making fewer visits and the advantage of having steadier service from a larger fuel bed under some circumstances might be regarded as more desirable.

Connections for A.C. and D.C. Service—How can we arrange connections of a 110-volt d.c. three-wire system from a 115-volt a.c. supply when the d.c. generator is out of service? G.R.

Outside a.c. current may be used by the method indicated in the sketch, in which use is made of a 2 to 1 step-up trans-



former with a tap at the midpoint of the secondary winding, as at *A*. Under these conditions the system will operate equally well on either a.c. or d.c. service.

Economy of Belt-Driven vs. Direct-Steam Feed Pump—What number of horsepower is required for operating a boiler-feed pump for a boiler that supplies steam at 100 lb. gage pressure to an engine developing 300 i.hp., assuming that 30 lb. of feed water is required per i.hp. per hour, and how much would be gained by using a belt-driven pump in place of a direct steam feed pump? M. H.

If it is assumed that 5 lb. per sq.in. is lost in pipe friction, the feed pump would discharge against a pressure of 105 lb. per sq.in., and as each pound pressure is equivalent to 2.31 ft. head of water, neglecting the suction pressure the net work would be equivalent to raising the water to a height of $2.31 \times 105 = 242.55$ ft., and to feed 9000 lb. of water per hour would require $(9000 \times 242.55) \div (60 \times 33{,}000) = 1.103$ actual or brake horsepower. The power required to operate the pump would depend on its efficiency. A belt-driven pump of the size required would have a mechanical efficiency of about 60 per cent. and the engine power required for its operation would be $1.103 \div 0.60 = 1.838$ net, or brake, horsepower. Assuming the mechanical efficiency of the engine to be 90 per cent. and of the power transmission to the pump as 85 per cent., then with an engine economy of 30 lb. of water per indicated horsepower per hour the feed-water steam consumption of the engine for operating the pump in addition to developing 300 i.hp. would amount to $[1.838 \div (0.90 \times 0.85) + 300] 30 = 9072.08$ lb. per hour.

A direct-acting steam pump of appropriate size would have a mechanical efficiency of about 60 per cent. and steam economy of about 150 lb. of steam per indicated horsepower per hour, and with this economy the feed-water consumption of a direct steam feed pump, and for 300 i.hp. developed by the engine, would amount to $(1.103 \div 0.60) 150 + (300 \times 30) = 9275.75$ lb. per hour. Hence, under the assumed conditions, the gain of steam economy from use of a belt-driven feed pump over employment of a direct steam pump for continuous boiler feeding would be $(9275.75 - 9072.08) \times 100 \div 9275.75 = 2.2$ per cent. This does not, however, take into account the superior evaporative economy of the boilers and the convenience of a steam pump in regulation of its speed to variable requirements or economy to be realized from use of the exhaust steam from the pump for heating the feed water or for other purposes for which the heat contained in the exhaust may be utilized.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Waste Due to Excessive Noncombustible in Coal

By W. A. SHOUDY
Mechanical Division, The J. G. White Engineering Corporation

The following is from a communication by the author to Gano Dunn, chairman, Engineering Committee, National Research Council.

THE percentage of ash has a distinct influence on the boiler efficiency. As the quantity of ash increases in percentage, it becomes more difficult for the fireman to completely burn the combustible. With a low percentage of ash and good firing we expect the ash removed from the boiler to contain approximately 25 per cent. of its own weight of unconsumed combustible. As the percentage of ash increases, the percentage of combustible lost in the ash also increases rapidly. With coal containing a high ash percentage it is rarely possible to reduce the percentage of combustible in the ash to under 50 per cent. of the weight of the ash.

This reduction in heat value is shown diagrammatically for varying percentages of ash in Fig. 1. The column at the left represents the heating value of ash-free coal, those at the right the relative values for coals containing varying percentages of ash. The upper stratum of each column represents the loss because the ash is incombustible. The second stratum shows an additional loss because of the presence of unconsumed combustible contained in the ash taken from boiler grates. The next stratum represents the loss due to the fact that steam boilers cannot be operated at 100 per cent. efficiency. The lowest stratum, therefore, represents the relative commercial values of coal containing varying percentages of ash.

Increase of Coal Consumption for a Given Power—On the basis of Fig. 1, Fig. 2 has been plotted. This shows the pounds of coal required to produce one boiler horsepower with coal of varying percentages of ash with careful operation. It will be noticed that for the best coal with 4 per cent. there is required approximately 3 lb. of coal per boiler horsepower, and that with 10 per cent. ash, less than 3½ lb. is required. Beyond this point the increase is rapid until for 21 per cent. ash the coal consumption amounts to 5.45 lb. per boiler horsepower-hour; 80 per cent. more than with 4 per cent. ash and about 60 per cent. more than with 10 per cent. ash.

Influence of High Ash on Boiler Capacity—The increase in the ash content of coal seriously reduces the capacity of steam boilers. The excessive quantity of poor coal required to deliver a horsepower, as shown by Fig. 2, makes it impossible to consume sufficient coal on the grate to deliver the necessary boiler horsepower. Central stations today are in a very serious condition because they find that their station load is increasing, but that the quality of coal has much decreased, necessitating the operation of a larger number of boilers. They find that whereas their boiler houses, two or three years ago, were of sufficient size to handle all ordinary increase in power demands, now, because of the poor quality of coal, it is difficult to provide the steam necessary to carry the station load. Up to within the last two years it was considered good practice to operate central-station boilers at 200 to 250 per cent. of their rated capacity during peak periods. In the same stations it is now difficult to operate at more than 150 to 160 per cent. of rating.

This phase of the subject is illustrated in Fig. 3, which shows the number of 500-hp. boilers required to generate 300,000 lb. of steam, equivalent to a peak of 15,000 to 20,000 kw. With coal containing 6 per cent. ash or less eight boilers can be made to do this work. If the ash runs higher than 6 per cent. nine boilers must be operated, above 10 per cent. eleven boilers would be required, and above 18 per cent. nineteen or twenty boilers. This situation is so bad that practically every large central station today has no spare boiler capacity, unless spare boilers have been purchased and installed within the last two years.

The effect upon industrial plants is similar to that experienced by the central stations, but in a different degree. Industrial plants do not operate their boilers at the high ratings experienced in central-station practice, but they do not as a rule carry so large a percentage of spare boiler equipment as central stations. They, therefore, find it necessary to operate their entire boiler equipment or curtail production, and their boilers are kept in service for longer periods than is good practice. It is impossible to take the boilers out of service long enough to properly clean them from scale and to properly repair baffles and brickwork in the furnaces. The consequence is that the boiler efficiency is seriously reduced until they are in such poor condition that they must be shut down for cleaning, at the expense of production. With reasonably clean coal this situation would not exist.

In all these charts it will be noted that the trouble from ash is not excessive until 10 to 12 per cent. content is

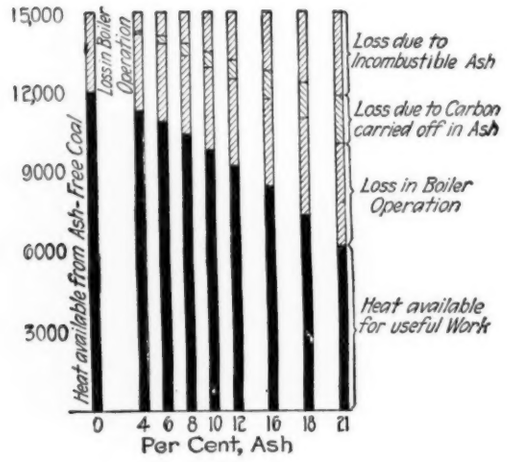


Fig. 1

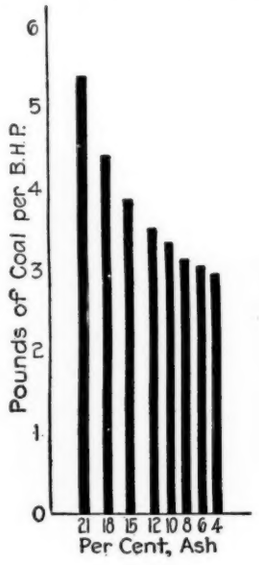


Fig. 2

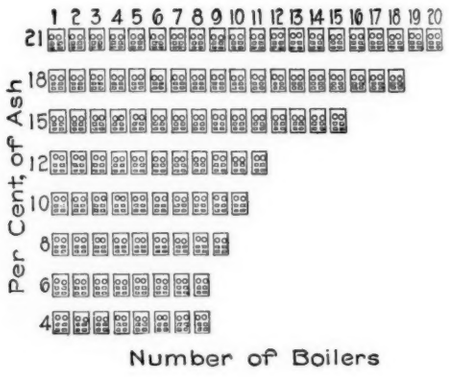


Fig. 3

SHOWING EFFECT OF LARGE QUANTITIES OF ASH IN COAL FOR STEAM BOILERS

passed. If, therefore, the percentage of ash might be limited to the average of 10 per cent., our transportation equipment would be reduced to a practical minimum; all boilers might be operated at a reasonable efficiency and the number of boilers operated could be reduced to a little over one-half of the number required for the dirty coal (that is, 18 per cent. ash or over), besides making a saving in money that cannot be accurately estimated.

How Best To Educate Power Plant Operators

By W. E. East*

Experience leads the Toledo (Ohio) Railways and Light Co. to believe that the best way to educate power-plant operators is to make arrangements to let them conduct their own educational work. It is believed best to have meetings at the plant when the men are off duty and to pay the men for the time thus occupied if necessary to secure full attendance. The classes should be run on a club basis. It has been learned that if a group of men from the "front office" try to initiate a movement for the benefit of the plant men, the whole plan will be viewed with suspicion. So educational work must proceed from the inside out, not from the outside in. The part of the company's officials and department heads in this work should be to make the operators feel the need of educational activities and then to let them take it among themselves, helping them, of course, if they desire help, but never trying to force assistance upon them.

It is also believed that such abstract studies as arithmetic, physics, electricity and mechanical drawing have no place in these meetings. Men who wish to take such subjects will avail themselves of other opportunities to learn them. The real province of the power-plant club is to take up problems of ordinary operation. Questions arise daily as to the best methods of operating stokers, boilers, condensers, etc. At a weekly get-together meeting the club can handle these topics. A fireman, for example, may have ideas of his own, based on his experience, as to how to operate his stokers. The boss may have told him to run his stokers in a way that seems quite wrong, but if he is the right sort of a fireman he will be willing to learn that he is wrong through discussion in the weekly meetings.

Meetings appear to be most successful when the program includes discussion and study of only one piece of apparatus. A good plan is to have someone previously appointed to give a description of the apparatus, illustrated with blueprints and catalogs. A question box should be established and used. If manufacturers' rules pertaining to operation of the apparatus are available, they should be read. Then the meeting should be thrown open for discussion by everyone from the ashman to the boss. Material and literature from manufacturers should be preserved to form a reference library for the club.

Water Street Boiler-Room Club

Employees of the Toledo company have such a club. It is known as the Water Street Boiler-Room Club, because its membership consists of practically every boiler-room operator at the Water Street generating station. Mr. Washburn, the boiler-room foreman, was instrumental in organizing it, and the men have supported it enthusiastically, electing him president. All suggestions are acted on by the club before the reports of those suggestions which seem worth while are submitted by the club president to the superintendent of production. The club, in general, works along the lines mentioned, although it also engages in some social activities. While the club is still young, successful results thus far indicate that it will serve to promote general welfare of the men and the company.

In addition to the boiler-room club, the employees and the Toledo company participate in other educational activities. One of these is the joint section of four national engineering societies, the National Electric Light Association, the American Gas Institution, the American Electric Railway Association and the National District Heating Association. The joint section was organized for the educational improvement of its members and to foster good fellowship through social events. It has conducted a number of weekly evening classes in arithmetic, algebra, electricity and mechanical drawing. Day classes have sometimes been held for night shifts. The company has paid for instructors and furnished the meeting room. The classes have been conducted on the same principle as classes in grade schools. On the whole, the work has been successful in teaching general subjects, and the joint section is largely responsible for other educational work which has since been started. As a further means of providing men with opportunities for general education the company pays three-fourths of the cost of a correspondence-school course if an employee completes the course.

Another plan that was used for a time to teach practical topics was the "station-operating class." As a part of this plan a course of study was laid out and speakers were assigned various topics as follows: Introductory meeting; outline and discussion of work planned; fuels and combustion; furnaces and stokers; boilers; coal- and ash-handling systems; draft systems, natural and mechanical; feed-water purifiers and heaters; superheaters, steam piping and auxiliaries; testing and measuring apparatus, and description of the Acme power station, East Toledo.

A number of these talks were illustrated. This class was well attended and considerable interest was aroused. The class was considered in that respect very successful. However, in another way this class was not successful in that it did not reach the large body of men it was intended to interest. The men who should have been present, the plant operators, were not there in a sufficiently large proportion, and the ones that were present would not partake in the discussion. In fact, most of the operators who came did not seem to feel at home and failed to get into the game as it was hoped they would.

Personal Training and Combustion Tests

Personal training is also being given to the firemen in connection with combustion tests which are run by the results department. These tests are made for the double purpose of checking up the accuracy of the boiler-flow meters, draft-gage settings, etc., and also enable the firemen to become familiar with the use of these instruments. The man who is running the tests and the fireman get together, and the tester tells the fireman that he wants to get the fire as hot as possible. He then shows the fireman what his boilers are doing, provided the boilers are equipped with meters, and they set out to improve conditions, if possible. Readings are taken of draft, boiler output, air flow, analysis of flue gases, stack temperature, etc., and the fireman is informed of all these readings as they are taken. Then as conditions are improved the results are pointed out to the fireman and he is shown how his boiler meter will guide him in his every-day operation of the fires and enable him to obtain the best results at all times. As an incentive to the fireman to make good records, methods calculated to inspire rivalry are pursued.

At the Water Street station the company also has a fireman's instructor, whose duties are to break in all new firemen and to teach them to make full use of all the boiler instruments. This man also supervises all the fires on all special tests and in that way keeps in touch with all the testing work that is carried on in the boiler room.

In conclusion the company believes that much good can be done in an educational way along all three lines; that is, general work, which takes up the fundamental subjects; the special classes, which include the operators' clubs; and the personal work, which is intended to give individual instruction. However, it is believed that the most successful endeavor and the one most profitable to the company is the operators' club. From experience that appears to be the best place to begin. After this club is in full operation, the demand for the more academic classes will become greater and the personal work will become easier and will accomplish more.

*From a paper presented before the station operating committee of the Ohio Electric Light Association.

Fuel-Oil Conservation Meeting at Chicago

ON Oct. 24 at the Hotel La Salle, Chicago, about 300 representatives from fuel-oil and coal-burning plants in the Illinois district assembled at the request of Nelson G. Phelps, district engineer, Bureau of Oil Conservation, for an all-day meeting. Although some attention was given to coal, the primary object of the gathering was to arouse enthusiasm in the conservation of oil, to point out wasteful practice and to indicate where improvements might be made. Officials from the Fuel Administration at Washington were present to assist the local organization.

Harold Almert, director of conservation for Illinois, who made an excellent chairman, pointed out the necessity of conserving oil from the standpoint of Government needs and the limited transportation facilities. The supply was falling far short of the demand, so that it was no longer a question about individuals, but a duty of all concerned to conserve petroleum products so badly needed in war work. The extensive purchase of new equipment could not be considered. It was a question of using fuel more economically in connection with present equipment. The Illinois district had been asked by Washington to conserve 3,125,000 tons of coal and 300,000 barrels of oil. The chairman requested the earnest coöperation of all fuel users, so that at the end of the year he could report to Washington that Illinois had gone over the top and done more than its share.

Fuel Situation in Illinois District

Raymond E. Durham, Federal fuel administrator for Illinois, confined his remarks to local conditions. He outlined the organization that had been perfected in the state and gave statistics to show that the fuel situation in Illinois was in a very satisfactory condition. The Chicago switching district alone used 30,000,000 tons of coal per year, as compared to 32,000,000 tons for all New England. These figures give some idea of the importance of Chicago as an industrial center. It uses approximately one-eighteenth of all the coal burned in the country. Reports from the various industries show that considerable coal has been stored and that Cook County has already received 76 per cent. of its domestic supply. The speaker said it was no time, however, to let up on the good work, for with continued effort there will be no necessity to curtail the supply of coal to any industry next winter.

Osborn Monnett, assistant advisory engineer of the United States Fuel Administration at Washington, stated that the national plan for the conservation of fuel from the standpoint of the Fuel Administration, divided itself into three problems. First, requirements; second, production; and third, conservation. The present struggle in Europe is a war of steel. Great quantities are needed for ships, shells, transportation, etc., and none of these things can be produced without coal. In a recent attack on the Western Front, as many shells were fired in 78 minutes as were used in the entire Franco-Prussian war. It took 225,000 tons of coal to fight the battle of St. Mihiel. To build a 3000-ton transport requires 8000 tons of coal, or nearly three complete cargoes. Then there is a continuous demand for operation and every additional transport increases the difficulties of supplying coal.

Loss of Labor at the Mines

At the start of the war there were 700,000 miners. About 60,000 of these were lost in the draft and many more to other industries paying higher wages. Notwithstanding this loss of labor, there was a 10 per cent. increase in production last year, and it is estimated that the percentage of increase for the present year will also reach 10 per cent. The present mining force has been asked to turn out this year 700,000,000 tons of coal, and this is about the limit of physical possibilities. This figure is several million tons short of the estimated requirements, and here is where conservation must come to the rescue.

The work at Washington is of a supervisory character, leaving local problems to be worked out by the various state administrative engineers. The purpose of the questionnaires is to develop the weak points in a plant, so that the Fuel Administration has the data from which to make suggestions for improvements, these to be worked out by the talent in the respective plant, or by local consulting engineers. The Fuel Administration is in no sense to be considered a consulting engineer's bureau.

Joseph Harrington, administrative engineer for Illinois, pointed out some of the practical methods of carrying out the conservation plan. He said that some 12,000 questionnaires had been sent out to coal-burning plants and many of them had been returned. In the ratings more plants were under 50 per cent. than over 70 per cent. In the majority of plants the boilers were wholly unequipped with anything to indicate efficiency; they were not covered properly, flue temperatures were high, settings were leaky, so that there was lots of room for improvement. The foregoing did not apply only to the small plants, for there were numerous large installations fully equipped with instruments and efficient apparatus that were not securing good economy, for the simple reason that the instruments were not used and the equipment not kept in good operating condition.

Conservation is largely a boiler-room problem, divided into the generation of heat and the absorption of heat. Heat production is a combustion problem where the manufactured product is allowed to escape up the stack and the byproduct, heat, utilized. The primary product, CO_2, measures the efficiency of the process, so that it is of utmost importance to know what percentage of CO_2 is being obtained. A recording instrument is preferable, but in a small plant may be considered expensive. In this event a sampling tank which will gather an average sample throughout the shift, and a hand instrument should be employed. A knowledge of draft throughout the setting helps greatly in maintaining efficient operating conditions. It is important to know the drop through the fuel bed and the drop through the setting. A recording thermometer in the flue gives a close approximation of the cleanliness of the heating surface and indicates the condition of the baffles, as well as infiltration through the setting. Above all, accurate records must be kept, for the operator must know what he is doing and reason from cause to effect before the efficiency can be improved.

Conditions in the power field are changing. Under the general manager the engineer is now the most important man in the plant. Owners have proved ready and willing to coöperate. It is necessary to tell them what to do and how to do it, so that education is the primary function of the department.

Present Situation of Fuel-Oil Supply

In summarizing the fuel-oil supply situation, W. C. Robinson, director of the Bureau of Oil Conservation, Washington, D. C., showed that most of the oil-producing fields had already passed their top production and were now on the decline. In 1917 the United States produced 341,000,000 bbl., or 14,322,000,000 gal. of fuel oil. This vast supply was not equal to the demand, for the estimates of the present year showed a shortage of 29,000,000 bbl. The importance of oil fuel in war operations was emphasized and with detailed figures the speaker brought home to the audience the great advantage of oil fuel over coal for marine purposes. The figures showed that 300 ships burning oil could do the work of 400 burning coal, and only one-third of the number of men were required as boiler-room crews. Owing to the cheapness of oil and the ease of obtaining it in pre-war times, there had been great carelessness and waste in burning this fuel. Attention must now be given to efficient burning. The speaker outlined the organization of the oil division and requested the Illinois district to adopt its slogan, "Stop the leaks and save the drops."

Nelson G. Phelps, district engineer, Bureau of Oil Conservation, then outlined the national plan for conservation of fuel oil. Careful investigation by the Bureau of Mines showed that at least 40,000,000 bbl. of fuel oil, equivalent to 1,680,000,000 gal., was being wasted every year by inefficient methods of operation. It had been found that three conditions were primarily responsible for this enormous

waste: (1) Poor combustion, (2) misapplication of the equipment and (3) neglected supervision of the plant. It was made plain that these inefficiencies could be eliminated without the expense of new equipment. It was the administration's purpose to save the oil with the present existing installation—as far as possible. Much of the responsibility for conserving oil rested with the plant executives. It was their duty to learn more about the fundamentals entering into the economic use of this fuel with the same degree of attention they now give to other costly items of production. Plant executives must shoulder the task of conservation. Mr. Phelps outlined the plan of action to be followed, consisting of sending out questionnaires, inspection of plants, recommendations for improvements, monthly reports and a follow-up system and reinspections. It was made plain that this was the oil-burners' program as much as it was the Government's. Mr. Phelps assured all of a fair deal and in return asked coöperation, so that it would be possible to report to Washington the complete saving assigned to the district.

Papers of the Afternoon Session

During the afternoon four interesting papers were presented, relating to fuel-oil systems with special reference to industrial furnaces. In the first paper, Max Sklovsky, mechanical engineer, Deere Co., Moline, Ill., gave valuable information on the use of fuel oil in industrial furnaces and the results of experiments obtained over a period of years by the company. By the use of charts the speaker demonstrated the great advantage of fuel oil over coke in this kind of work. In one of the company's plants, the average efficiency for 251 furnaces proved to be 9.2 per cent., which might be compared to 4 to 5 per cent., the general average throughout the country. Improvements in efficiency had been effected by preheating the air of combustion by the waste gases from the furnace to a temperature approximating 700 deg. F. The oil was injected into this air in a mixing receptacle, vaporized and thoroughly mixed with the proper proportion of air, and was delivered to the furnace in gaseous form. Building furnaces to make them air-tight had reduced the losses. A comparison between the old straight-type furnace and the new furnace burning the oil in the form of gas and preheating with waste heat showed that the oil consumption was reduced to practically one-third of the quantity formerly required.

Aside from the method of burning, there were other losses that might be avoided. Leakage was usually small. The time taken in starting up a furnace might be considerably reduced. In some plants, starting up required two hours as compared to 15 minutes, the time taken in the Deere shops. For the maximum efficiency continuous operation was important. In some shops there were too many resting periods where the men were idle and the furnaces in operation. In most fields it was the custom to get apparatus big enough to do the work. In oil burning, however, the practice should be toward small well-built furnaces, specialized for the work they are to do. As 90 per cent. of the expense of operation is in maintenance, it is important that the furnace be made small enough to do the work to the best advantage.

Practical Suggestions as to Storage

"Oil Storage and Measurement" was the subject of J. J. Connelly, who gave numerous practical suggestions in connection with storage tanks, pipe lines to the furnaces and meters to measure the oil used. As pointed out by Mr. Phelps, a meter or some measuring device is essential to improve or even to determine what economy is being obtained. In his district less than 100 per cent. of the plants had reported any system of measuring the oil. In installations without meters, the oil consumption could be measured by gaging the tanks. This was one of the real essentials and his department would insist that some method of measurement must be inaugurated in every plant.

J. C. Miller spoke on "The Value of Fuel-Oil Accounting Systems." By various comparisons the author showed the necessity for and the value of records. For each furnace account should be kept of the oil consumption per burner, the hours of service and the tons of product handled. From these data the operator knows exactly what the furnace is doing. Efficient operation can come only from a knowledge that present methods are uneconomical. The only way to determine this is from records and cost keeping.

The final paper of the session was devoted to "Fuel-Oil Combustion in Industrial Furnaces." The author, Joseph W. Hays, compared the combustion of fuel oil to coal burning, enumerated in a general way the conditions required for efficient combustion, and in his closing remarks made a strong plea for the use of CO_2 instruments. In boiler operation this instrument is of vital importance, but, as pointed out by Mr. Phelps, the analysis of gases from industrial furnaces is impractical in a great many cases. The degree of combustion could be determined, however, by observance of the flame. An intense white flame indicates large quantities of surplus air. A flame of yellowish appearance, giving off smoke, is an indication of too little air. Combustion is about right when the flame has a light brown appearance. Suggestions for improvement, issued by the oil division, were then read by Mr. Phelps, who stood ready to render every assistance possible to fuel-oil burners of the district.

Examination for Petroleum Technologist

The United States Civil Service Commission announces an open competitive examination for petroleum technologist, for men only. Salaries range from $2500 to $3000 a year. The duties of this position will include investigations of methods of producing oil and gas and of protecting oil- and gas-bearing sands from the infiltration of water; also studies of the relation of oil, gas and water to geologic structure in the oil fields of the United States.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated: (1) Education, 40, (2) experience, 60. Graduation in geology from a college or university of recognized standing, and at least three years' experience in geologic work connected with productive and prospective oil fields of this country, are prerequisites for consideration for this position.

Applicants should at once apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.; the Secretary of the United States Civil Service Board, Customhouse, Boston, Mass.; New York City; New Orleans, La.; Honolulu, Hawaii; Post Office, Philadelphia, Penn.; Atlanta, Ga.; Cincinnati, Ohio; Chicago, Ill.; St. Paul, Minn.; Seattle, Wash.; San Francisco, Cal.; Old Customhouse, St. Louis, Mo.; Administration Building, Balboa Heights, Canal Zone; or to the Chairman of the Porto Rican Civil Service Commission, San Juan, P. R. Applications must be filed with the Civil Service Commission, Washington, D. C., prior to the hour of closing business on Nov. 12, 1918.

Research Council Wants Information on Laboratories

Engineering Foundation and National Research Council are coöperating in compiling information about the research laboratories of the country in promoting industrial research. The purpose is to aid the Government and the industries in war work and to further the welfare of the world through the advancement of American industry, engineering and science. To do this they request all laboratories which have not yet done so to send to the New York office at 29 West 39th St. a brief statement covering: Equipment—not a detailed list, but a summary indicating kinds and capacities in a general way and mentioning apparatus of unusual character or size; research work—general kinds, with reference, if permissible, to special problems which would indicate the scope of the work which the laboratory can undertake; staff—classes, such as chemists, physicists, engineers, assistants; number of each; name of person in charge, and research time—all, half, one-third, or other approximation.

The Fuel Administration estimates that the "skip-stop" system, adopted throughout the nation Sept. 15 by street railways, will save 1,500,000 tons of coal annually. It requires three times as much electric current to start a car as to run it a block.

College for Merchant Marine Firemen Established by United States Shipping Board

Chicago Hotel converted into a school at which young Americans by the hundred are prepared for scientifically keeping the fires burning on the nation's "Bridge of Ships to Europe." An intensive course of study on combustion combined with practical demonstrations in firing at city power plants. Character and purpose of the American marine fireman defended by Edward N. Hurley, chairman of the Shipping Board. Great need of men in firerooms of merchant ships and young Americans are responding readily to calls for their service behind the shovel.

AMONG the training projects of the various branches of the Government that have grown out of the war, the United States Shipping Board announces the launching of one that has the distinction of novelty. It is a technical school, or "college," for merchant marine firemen. Holding that the marine fireman's job is more than merely shoveling coal on a fire, the Shipping Board has prepared for intensive, scientific training of its firemen before they are placed behind the shovel on our bridge of ships to Europe.

One aim in this training is to secure conservation of coal. It is believed that a fireman who knows the heat value of the fuel he is handling, the laws of combustion and the principles of operation of the boilers under which he maintains fires, can save at least a ton of coal a week, as compared with the untrained man, or one who has been trained only by "rule of thumb." As there are estimated to be 7000 American and Allied ships in service at this time, the importance of this principle of saving is apparent.

Firemen To Be Placed on a Higher Plane

But the purpose of the Shipping Board in establishing its college for firemen is deeper than the mere announcement of the training method indicates. The starting of the school in fact is an announcement that the Shipping Board has officially taken up the case of the merchant-marine fireman and is prepared to put him on a different plane than he has occupied hitherto.

By recruiting clean-cut young Americans for fireroom duty and giving them special training, considerate treatment and improved quarters aboard ship, the board aims to remove the reproach that for years past has stood against the calling of the marine fireman.

The Shipping Board today also is refuting the old claim that to be a marine fireman is to be a "rough neck." Edward N. Hurley, chairman of the board, after some study of the marine fireman, came to the conclusion that this point of view was unfair both to the fireman and to the country. He discerned in the fireman of today a silent hero, taking the brunt of danger in the stokehold without a murmur, serving his country faithfully with no hope of acclaim from the public.

This official view of the fireman has been reflected in Mr. Hurley's recent calls for volunteers for fireroom service.

"The man behind the shovel is the man of the hour," said the Shipping Board chairman in a speech at Chicago. "The men in the firerooms of our merchant ships are in our first line of defense," said Mr. Hurley last week.

This being the view of the Shipping Board, a step toward better fitting the fireman for his work was a logical one. In working out the details of the project, the Board followed a twofold purpose—increasing fireroom efficiency and maintaining a high standard of fireroom personnel.

The Chicago school for firemen was decided upon as a means of employing to the fullest the high-grade material that was coming into the fireroom service of the merchant marine in the Middle West, in common with other sections. In order that the young men should have proper care while studying, the idea of an official community was adopted. A disused hotel in a downtown section was secured and fitted up on the lines of a seminary, with living quarters for 500 students, and a spacious lecture hall, all under one roof. Here, under the direction of instructors and proctors—the latter are a kind of glorified master-at-arms—the students lead a busy and wholesome life. It is a case of plain living and high thinking with them, for their time is limited at the school to one month at the outside, and there is much for them to learn. Some of the men having fired boilers before attending the school, find the instruction a valuable post-graduate course.

The main subjects are materials of combustion, process of combustion, types of boilers, boiler parts and accessories, and oil burners for marine boilers. There are also talks on fireroom practice and the relations of the fireman to the engineers, oilers and water tenders with whom he works at sea. Part of each day is devoted to actual firing.

The school day begins with assembly on sick call, at 8:30 a.m., when the students are lined up before an examining physician, who examines any who show signs of illness. At 9 the lectures begin. With a brief interval for lunch they last until 4 p.m. At 4 there is a roll call for drill and calisthenics. Students not attending lectures are absent firing boilers, in little squads, each under the direction of a proctor. Some of this firing is done at power plants and some on lake steamers making short trips.

There is recreation for the men in the evening and "shore leave." This is granted only on request to a proctor. At 10:30 p.m. sleeping rooms are inspected, and at 11 p.m. all lights are out.

The men in the school have recently been authorized to wear the blue uniform of the Shipping Board Recruiting service.

When a student has absorbed the "book learning" in the Chicago course, he is sent to a seaport for a final course of instruction and to "get his sea legs," on one of the Shipping Board's twelve training ships.

Present Urgent Need of Firemen

In describing the school, Chairman Hurley spoke with earnestness of the pressing need of firemen at this time. "The ships are coming fast," he said, "and we need at this moment 2000 young men to be trained as firemen." In order to take care of that many, the proportion of firemen accepted on the Board's training ships has been increased.

Strong young men are now coming forward in large numbers for fireroom training for the first time in the history of the merchant marine. This is due in part to an understanding by young Americans of the important character of service in the fireroom and in part to the Shipping Board's recognition of the standing and loyalty of marine firemen as a whole.

Volunteers are being signed up in every state in the union. Candidates accepted are from 18 to 35 inclusive, and must weigh at least 140 pounds. The Board will pay the fare to Chicago of volunteers from Ohio, Michigan, Illinois, Indiana, Wisconsin, Minnesota, the Dakotas, Nebraska, Iowa, Missouri and Kansas, and thence to a seaport, and also give them their board at Chicago. The fare of men from other states will be paid direct to a seaport, where they will be trained. In either case the volunteer will receive $30 a month training pay. When he gets behind the shovel at sea, he will be given $75 a month, with 50 per cent. added for voyages through the European war zone.

The United States Fuel Administration is desirous of securing catalogs of dealers in power-plant accessories. Publications of this kind should be addressed to David Moffat Myers, Advisory Engineer, United States Fuel Administration, Washington, D. C.

Obituary

Lieut. Charles R. Seed, U. S. N. R., for the last seven years superintendent of power or chief engineer of the Worcester (Mass.) Electric Light Co., died recently at the Hahnemann Hospital, Worcester, of pneumonia. "Charlie Seed," as he was known to many operating engineers in New England, was only 43 years of age, and survived a year of strenuous service in the war zone off the coast of France on the U. S. S. "Wavika," only to fall a victim to the epidemic on this side during his later period of duty at the Fore River Shipbuilding Co.'s yard in Quincy, Mass. Like many another engineer, he settled into the field of stationary steam-plant operation after an extended training and experience in transatlantic service.

Lieutenant Seed was a native of Lawrence, Mass., and was trained aboard the Massachusetts Nautical schoolship "Enterprise," after which he served for seven years as an engineer on runs between America and Europe. For a short time he was engineer of industrial plants at Utica, N. Y., and Blackstone, Mass., later becoming chief engineer of the Rockingham County Light and Power Co. of Portsmouth, N. H. Since 1911 he had been with the Worcester company. During the Spanish-American War he served as junior engineer aboard the "St. Louis." When war was declared by the United States against Germany he at once offered his services, and soon was commissioned ensign and assigned to the Boston Navy Yard. After a short time he was ordered overseas, and during his patrol duty was promoted to lieutenant.

The Worcester company had granted him a leave of absence for the period of the war, and on his return to the United States he was assigned to the Fore River shipyard and actively employed in connection with the fitting out of vessels with motive power for sea duty. This enabled him to spend a part of his time among old friends in the engineering profession at Worcester and Boston, and he was a recent speaker at a meeting of H. E. Stone Chapter, N. A. S. E. His untimely death was a shock to a large circle of friends.

Personals

H. D. Megary has been elected to the office of secretary of the Chicago Pneumatic Tool Co., to replace W. B. Seelig, resigned.

Fred W. Fischer has severed his connection with the United States Nitrate Plant at Muscle Shoals, Ala., to accept an appointment as boiler-plant supervisor with the Du Pont Engineering Co.

H. O'Neill, formerly with the West Virginia Pulp and Paper Co., left that company Oct. 1 to take a position as mechanical engineer with Ford, Bacon & Davis, 115 Broadway, New York City.

D. T. Gaston has been appointed general manager of the Columbus (Miss.) Railway, Light and Power Co. to succeed Charles Hays, who recently resigned to accept a position in the engineering branch of the War Department.

H. M. Gassman, who was chief engineer for the Tennessee Coal, Iron and Railroad Company for several years and later engaged in general consulting engineering, has been appointed associate chief of conservation for Alabama, by the U. S. Fuel Administration.

Erskine Ramsay of Birmingham, Ala., has been appointed by the U. S. Fuel Administration as chief of conservation for the state. Mr. Ramsay has been identified with the mining interests of the Birmingham district for nearly thirty years, and many of the improved methods of mining and handling coal are due to his skill and initiative. For several years past he has been first vice president and chief engineer of the Pratt Consolidated Coal Co., and is a director and member of the executive committee of the National Coal Association.

Engineering Affairs

The National Association of Practical Refrigerating Engineers will hold its annual convention at Oklahoma City, Okla., Dec. 5-7, with headquarters at the Skirvin Hotel.

Miscellaneous News

A Locomotive Boiler Exploded on the Baltimore and Ohio R.R. tracks at Columbus, Ohio, on Oct. 20, killing two persons and causing damage estimated at $20,000. The cause of the explosion is given as low water.

An Overheated Transformer Exploded as a result of a short-circuit, at the plant of the Niagara, Lockport and Ontario Power Co., at Lyons, N. Y., on Oct. 20, causing damage to the power plant estimated at $200,000.

The Explosion of a Steam Pipe at the plant of the Memphis (Tenn.) Gas and Electric Co. early Monday morning, Oct. 28, put practically all power plants out of commission for the day. Several persons were injured. Repairs were completed and lights turned on again at 10 p. m. Monday.

New Power Plant—The second half-million-dollar power plant of the Columbia Power Co., near Columbia, Ala., is now being built, material having been unloaded for the purpose at Omussee Siding. It will require three or four months to complete the plant. It will be used as an auxiliary to the first plant, which has about been completed, and which began furnishing power to Dothan and Columbia Oct. 1.

Business Items

The Carlin Turbine Blower Co., of Worcester, Mass., which recently began business at the plant of the Economic Machinery Co., has been incorporated under the laws of Massachusetts with a capital stock of $25,000 to make blower apparatus.

The Barber-Greene Co. announces the strengthening of its organization as follows: F. E. Smith, chief engineer, formerly of the engineering department of the Stephens-Adamson Manufacturing Co., of the Granby Mining & Smelting Co., and the American Zinc & Chemical Co.; Geo. C. Sanford, superintendent, formerly of the Elevator Supplies Co., and of the Otis Elevator Co.

The New York Belting and Packing Co. because of its rapid growth has been obliged to make extensive additions and alterations to its plant at Passaic, N. J. Several modern reinforced-concrete buildings are in course of construction, including two large manufacturing buildings, power house, enlarged office building and many changes throughout to render the plant modern in every respect. A completely equipped machine shop will take care of the making of various intricate molds used in rubber manufacture as well as the upkeep and construction of machinery.

Trade Catalogs

Jeffrey Belt Conveyors. The Jeffrey Manufacturing Co., Columbus, Ohio. Catalog No. 175. Pages 80; 6¼ x 9 in. A complete textbook covering all phases of the belt conveyor.

The Brown Hoisting Machinery Co., of Cleveland, Ohio, has just issued a 56-page catalog entitled "Brownhoist," which gives a complete and illustrated description of the company's products. A copy may be had free upon request.

The Yarnall-Waring Co., of Philadelphia, Penn., has just issued a set of bulletins fully describing and illustrating Yarway power-plant devices. They are attractively bound in a 6½ x 9½-in. binder inscribed "Engineering Devices for the Power Plant."

The Crescent Belt Fastener Co., of New York City, has just issued a 24-page booklet entitled "Gone Again," which is written in the way of a "movie" comedy, treating the subject of belt joining in a humorous way. A copy with full technical and practical information will be sent to anyone free on request.

The Graton & Knight Manufacturing Co., of Worcester, Mass., has recently issued a 40-page booklet entitled "Standardized Leather Belting," which explains the value of a standardization of belting, and of machine parts, and its application in the plant. A section devoted to mechanical rules and tables should prove of value to any belting user in determining the horsepower of belting, width and length required. Another section is devoted to belting standard recommendations for leading industries. Anyone interested in power transmission may obtain a copy of this booklet upon request.

New Construction

PROPOSED WORK

Mass., Chelsea—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will install a heating system here; Specification No. 3597. Estimated cost, $25,000.

Mass., East Deerfield—The Boston & Maine R. R., North Station, Boston, will install a steam heating system in the new concrete and brick building to be occupied by the Railroad Y. M. C. A. Total estimated cost, $150,000. A. B. Corthell, Boston, Ch. Engr.

Conn., Hartford—Swift & Co., 60 North Market St., Boston, Mass., will soon receive bids for the construction of a cold storage plant and office building on Church St. Estimated cost, $90,000. A. E. Bump, 60 North Market St., Boston, Mass., Engr.

N. Y., Herkimer—The Municipal Commission, City Hall, has had plans prepared by H. B. Sweet, Engr., Clarendon Bldg., Utica, for the construction of a 1 story addition to its boiler plant here. Estimated cost, $50,000. M. Foley, Pres.

N. Y., Long Island—S. Blickman, 199 Lafayette St., New York City, will install a steam heating system in the proposed 5 story, 200 x 600 ft. factory on Mott Ave. and Manby St.

N. Y., Tompkinsville—Supt. of Lighthouses, Tompkinsville, will receive bids until Nov. 14 for one electric welding outfit.

N. Y., Utica—E. S. Elwood, secretary of the State Hospital Commission, Albany, is receiving bids for the reconstruction of a boiler room, also the installation of boilers and changes in the central heating plant at the Utica State Hospital.

Penn., Altoona—The Pennsylvania R. R. plans to build an addition to its electric power plant here. A. C. Shand, Broad St. Sta., Philadelphia, Ch. Engr.

Penn., Marietta—The Pennsylvania Railroad Co. will soon award the contract for the construction of an engine house, power house, shop buildings, etc. Total estimated cost, $500,000. A. C. Shand, Broad St. Sta., Philadelphia, Ch. Engr.

N. C., Wilmington—T. Meares, City Clerk, will receive bids until Nov. 18 for the installation of a 5,000,000 gallon centrifugal pump, steam driven turbine engine, etc., in connection with the improvements and enlargements to its water-works pumping station at Hilton Park.

Ala., Wayne—The city plans to improve its electric light plant and install new machinery. Estimated cost, $25,000. Address the Mayor.

Miss., Clarksdale—The City Commissioners will soon award the contract for the installation of a 500 h.p. water-tube boiler in the water and electric light plant. W. W. Pointer, Supt. Water & Light Department.

Ky., Prestonburg—The Eastern Kentucky Service Co. plans to build a power plant.

Ohio, Carthage (Elmwood Place, P. O.)—The Standard Parts Co., 520 Hickcox Bldg., Cleveland, will install a steam heating system in the proposed 1 story factory. Estimated cost, $100,000.

Ind., East Chicago—W. L. Dunn, Engr., is receiving bids for the construction of a 30 x 60 ft. pumping station and 8 x 10 ft. boiler plant for the International Lead Co., 151st St. and McCook Ave.

Mich., Battle Creek—The Kellogg Toasted Corn Flakes Co., Porter and Stiles St., will build a 2000 h.p. addition to its present power plant. H. H. Lane, 2320 Dime Bank Bldg., Detroit, Engr.

Mich., Detroit—The Michigan Smelting & Refining Co., 1685 Joseph Campau Ave., is in the market for a 125 h.p. boiler, feed water pump and accessories for its proposed new factory.

Mich., Hamtramck—The Michigan Smelting & Refining Co. plans to build a 1 story, 44 x 448 ft. power house. Estimated cost, $10,000.

Mich., Wyandotte—The city is having plans prepared by R. W. Pratt, Engr., Hippodrome Bldg., Cleveland, Ohio, for installing a complete water filtration plant to consist of brick and concrete buildings, concrete clear water basin, pumping machinery, air compressors, etc. Estimated cost, $100,000.

Iowa, Clarinda—The city will install high pressure pumps, pipe line, intake, rapid filter, etc., in connection with the extensions and improvement it will make to its water-works. I. H. Taggert, Mayor.

Minn., St. Paul—The Northern Pacific Mutual Benefit Association Railroad Building will receive bids in February for the

construction of a power plant in connection with the hospital it plans to build at Simpson and Edmund St. Total estimated cost, $300,000. Lambert Bassindale, 321 Capital Bldg., Arch. Noted June 11.

Ark., Little Rock—The City Commissioners plan to establish a municipal electric light plant.

Okla. Stillwater—The city plans to build a filter plant, engine room, and brick boiler room. Total estimated cost, $175,000.

Okla., Tulsa—The city will soon receive bids for the installation of an 8,000 gallon low duty pump and extension to the water mains in West Tulsa. H. H. Wyss, Engr.

Colo., Leadville—The Fanny Rawlings Mining Co. will rebuild its plant which was recently destroyed by fire. A 50 h.p. hoist and motor and other electrical equipment will be installed. Total estimated cost, $10,000. W. C. Frost, Supt.

Ont., Goderich—The National Shipbuilding Co. plans to build a 1 story, concrete and brick boiler house and is in the market for machinery and equipment. Estimated cost, $75,000.

Sask., Wapella—W. P. MacDonald plans to build an electric light plant and is in the market for dynamo engine and general equipment for same. Estimated cost, $50,000.

CONTRACTS AWARDED

Conn., Hartford—The Standard Oil Co., 26 Broadway, New York City, N. Y., has awarded the contract for the construction of a concrete and brick pump house, boiler house, gate house, etc., to the H. D. Best Co., Flatiron Bldg, New York City, N. Y. Estimated cost, $100,000.

Conn., New London—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing heating system in State Pier Barracks, from Engles Hendricks, 47 Banker St., Boston, Mass., $44,965 (60 days); Raymond R. Bill, 59 Fort St., Springfield, Mass., $53,825 (60 days); Raisler Heating Co., 129 Amsterdam Ave., New York City, N. Y., $54,900 (60 days).

N. Y., Blackwells Island—F. L. Dowling, Pres. of Manhattan Borough, has awarded the contract for installing extra set of 2300 volt bus bars and replacing existing set, also installing additional panels, switches, buses, etc., and changing gallery in substation, Blackwells Island, to T. Frederick Jackson, 99 John St Estimated cost, $9900. Noted Oct. 29.

N. Y., Brooklyn—Julius Kayser & Co., 45 East 17th St., New York City, will build a 1 story, 25 x 50 ft. boiler plant on Classon Ave., near DeKalb Ave.

N. Y., Tonawanda—The Pierce Arrow Motor Car Co., 1695 Elmwood Ave., Buffalo, has awarded the contract for the construction of a 20 x 30 ft. boiler plant, on River Road, to the J. W. Cowper Co., Fidelity Bldg., Buffalo.

N. J., Camden—The New York Shipbuilding Co., Broadway and Fairview Ave., has awarded the contract for the construction of a 1 story motor driven pumping plant, to Armstrong & Latta, 110 South Broad St., Philadelphia, Penn. Estimated cost, $35,000.

Penn., Meadville—The Erie Railroad, 50 Church St., New York City, N. Y., has awarded the contract for the construction of several 1 story buildings for engine terminal here, to the Watson Engineering Co., 1150 Leader News Bldg., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

Penn., Philadelphia—The Baugh & Sons Co., Morris St. and Delaware Ave., will build a 2 story, 38 x 46 ft. boiler house. Estimated cost, $20,000. E. Armstrong, in charge.

Md., Baltimore—The Mt. Vernon-Woodberry Mills, 506 Continental Bldg., has awarded the contract for the construction of a 1 story, 40 x 100 ft. power house, to Gladfelter & Chambers, 36th St. and Roland Ave.

Md., Ellicott City—The C. A. Gambrill Manufacturing Co., 110 Commerce St., Baltimore, has awarded the contract for the construction on an addition to its boiler house, etc., to the West Construction Co., 908 American Bldg., Baltimore.

Va., Portmouth—The Emergency Construction Co., Law Building, Suffolk, has awarded the contract for increasing the capacity of power house, etc., in connection with the improvements to the Portsmouth, Berkeley and Suffolk water supply, to the Olen Contracting Co., 38 South Dearborn St., Chicago, Ill. Total estimated cost, $2,000,000. Captain Moore, R. H. Gordon and H. Q. Kennedy, U. S. A., will supervise the construction. This is part of Government plan to acquire and improve public utilities in this section.

W. Va., Charleston—The West Virginia Water & Electric Co., 131 Summers St., has awarded the contract for improvements to its electric- power and water plant, including pump house and intake from river, with installation of 2 electrically driven centrifugal water pumps to have a daily capacity of 18,000,000 gallons and reservoir having a capacity of 2,000,000 gallons, to the Charleston Concrete Construction Co., Charleston. Plans and supervision of work under James H. Fuertes, 140 Nassau St., New York City, N. Y. Noted Sept. 3.

Ohio, Akron—The Firestone Tire & Rubber Co., South Main St., has awarded the contract for the construction of a 1 story, 79 x 102 and 58 x 60 ft. power house at Plant No. 2, to the Carmichael Construction Co., 524 Hamilton Bldg. Estimated cost, $75,000.

Ohio, Cleveland—The Board of Education, East 6th St. and Rockwell Ave., has awarded the contract for the construction of a 1 story, 40 x 70 ft. boiler house, to William Moore, 1278 West 4th St. Contract for installing a steam heating system awarded to the Miles Heating & Ventilating Co., Engineers Bldg. Total estimated cost, $20,000 .

Mich., Lansing—The Olds Motor Co., 1101 Division St., will soon award the contract for the construction of a 1 story, 60 x 80 ft. power house. Estimated cost, $10,000.

Iowa, Cedar Rapids—Douglas Co. has awarded the contract for the construction of a 2 story, 59 x 120 ft. pumping station, to the Leonard Construction Co., 332-8 Michigan Ave., Chicago, Ill. Estimated cost, $100,000.

Kan., Buffalo—The city has awarded the following contracts in connection with improvements to its electric light and power plant; engines and generators, to Fairbanks-Morse Co., 13th and Liberty St., Kansas City, Mo., $9900; switchboard, to Westinghouse Electric Co., Orear-Leslie Bldg., Kansas City, Mo., $1100; power house will be handled locally. Noted Oct. 22.

Mo., Kansas City—The Kansas City Light & Power Co., 15th St. and Grand Ave., will soon award the contract for the construction of a 1 story, 50 x 57 ft. sub-station on 12th St., near Bristol Ave. Cost, between $15,000 and $20,000. Sargent & Lundy, 72 Adams St., Chicago, Ill., Engrs.

Ont., Peterborough—The Quaker Oats Co. has awarded the contract for the installation of a water turbine in the power house on London St., to develop 2250 h.p. at a speed of 180 r.p.m. under 27 ft. head, to William Hamilton Co., Ltd., Peterborough.

WASHINGTON, D. C.

Bids were received by the Bureau of Supplies & Accounts, Navy Department, for furnishing equipment as follows:

Schedule No. 6368½, Class 1636, one electric air compressor, delivery Washington, D. C., from Norwalk Iron Works, Water St., South Norwalk, Conn., $7727; Ingersoll-Rand Co., 11 Broadway, New York City, N. Y. (unit prices). Noted Oct. 15.

Schedule No. 6370½, steam towing machine, delivery Puget Sound, Wash., from American Engineering Co., Aramingo Ave. and East Cumberland St., Philadelphia, Penn., $110,169. Noted Oct. 15.

Schedule No. 6471½, Class 1773, motor generator set, delivery Washington, D. C., from General Electric Co., River Road, Schenectady, N. Y., $2266; Triumph Electric Co., South St., Cincinnati, Ohio, $2960; Triumph Electric Co., Liberty Bldg., Philadelphia, Penn., $2750; Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Washington, D. C., $2968. Noted Oct. 22.

Schedule No. 6388½, Class 1720, one motor driven shear, delivery Puget Sound, Wash., from Birch & Co., Cambridge City, Ind., $6186 alternate $6316; Niagara Machine & Tool Works, 683 Northland Ave., Buffalo, N. Y., $5317; National Twist Drill & Tool Co., 1456 Brush St., Detroit, Mich., $3435; Niles Bement Pond, 111 Broadway, New York City, N. Y., $3435. Class 1722, one motor driven punch, delivery Puget Sound, Wash., from Grand Rapids Grinder & Machine Co., 31 Ottawa St., Grand Rapids, Mich., $3775; Niles, Bement Pond, 111 Broadway, New York City, N. Y., $5160; George A. Ohl & Co., Newark, N. Y., $3455; William White & Co., 3rd Ave. and 8th St., Moline, Ill., $7200.

Schedule No. 6562½, Class 1853, motor generator set, delivery Connecticut, from Allis-Chalmers Co., Clinton St., Milwaukee, Wis., $10,954; General Electric Co., River Road, Schenectady, N. Y., $7700; Burke Electric Co., 12th and Cranberry St., Erie, Penn., $13,520, alternate $12,120. Class 1854, motor generator set, delivery Connecticut, from Allis-Chalmers Co., Clinton St., Milwaukee, Wis., $2621 (part bid); Moleney Electric Co., 711 13th St., Washington, D. C., $2115 (part bid) $2280.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck.	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10, other rates p. 95.

PRICES—MATERIALS AND SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in.		85c. per ft.
Common, 2½-in.		25%

	Air		
	First Grade	Second Grade	Third Grade
½-in. per ft.	$0.65	$0.40	$0.30

Steam—Discounts from List

First grade..... 15% Second grade.....25% Third grade.....33⅓%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 50% Best grade..... 30%
Standard..... 40%

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40+5%	35%
St. Louis	45%	40%
Chicago	45%	40%
Birmingham	35%	35%
Denver	35-5%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.99
Asbestos for high-pressure steam	1.76
Duck and rubber for piston packing	1.10
Flax, regular	.99
Flax, waterproofed	1.21
Compressed asbestos sheet	1.10
Wire insertion asbestos sheet	1.32
Rubber sheet	.66
Rubber sheet, wire insertion	.99
Rubber sheet, duck insertion	.55
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.21
Asbestos wick, ¼- and 1-lb. balls	.75

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure..... Llist

For low-pressure heating and return lines { 4-ply..... 58% off; 3-ply..... 60% off; 2-ply..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5½	13	8	12½
Fiber or sponge	8	6	13	8	20
Transmission	7	6	13	8½	20
Axle	4½	4	4.1	4	5½
Gear	4½	4½	7.0	8	9
Car journal	22 (gal.)	3½	4.3	5	8½

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	13.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	12.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	$52.00	$58.00
Chicago	48.00	50.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrel	$1.61	$1.23	$1.85	$1.30	$1.65	$1.27
5-gal. cans	1.71	1.33	2.00	1.40	1.85	1.37

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Current		1 Year Ago		Current Dry and In Oil	1 Yr. Ago Dry and In Oil
	Dry	In Oil	Dry	In Oil		
100-lb. keg	14.00	14.50	12.25	12.50	14.00	12.00
25- and 50-lb. kegs	14.25	14.75	12.50	12.75	14.25	12.25
12½-lb. keg	14.50	15.00	12.75	13.00	14.50	12.50
5-lb. cans	.....	.....	14.25	14.00	16.00	14.50
1-lb. cans	.....	.....	14.25	14.50	17.00	14.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	45-5%	45%
Tinned	30%	45-5%	45%

Button heads, ½, ¾, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York...$5.65 Cleveland...$5.15 Chicago....$5.67 Pittsburgh... 4.65

Coneheads, same sizes:

New York...$5.75 Cleveland...$5.25 Chicago....$5.77 Pittsburgh...$4.75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$175.00
Chrome cement	net ton	75.00
Clay brick, 1st quality fireclay	per 1000	50.00- 55.00
Clay brick, 2nd quality	per 1000	35.00- 40.00
Magnesite, raw	per ton	30.00- 35.00
Magnesite, calcined	per ton	32.00- 35.00
Magnesite, dead burned	net ton	32.00- 35.00
Magnesite brick, 9 x 4½ x 2½ in.	net ton	110.00-125.00
Silica brick	per 1000	50.00- 60.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55; St. Louis grade, $40.
Birmingham—Fire clay, $50; silica, $50; magnesite, $110; chrome, $165.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	95.00	70.00	93.00	73.00	96.00	70.00
Commercial	50.00	40.00	23.00	22.00	25.00	25.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$16-19	$14.00
Cleveland	20.00	15.00
Chicago	19.00	13.00

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft.	$5.82	$5.17	$4.55	$5.17
7 in. by 30 ft.	7.65	6.85	6.10	6.85
7 in. by 35 ft.	11.10	10.00	8.95	10.00
8 in. by 35 ft.	12.65	11.35	10.10	11.35
7 in. by 40 ft.	12.85	11.50	10.20	11.50
8 in. by 45 ft.	18.90	16.90	15.00	16.90
8 in. by 50 ft.	22.65	20.30	18.00	20.30

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$9.00
12-in. butts, 6-in. tops, length 30-40 ft.	11.50
12-in. butts, 6-in. tops, length 41-50 ft.	12.50
14-in. butts, 6-in. tops, length 51-60 ft.	21.00
14-in. butts, 6-in. tops, length 61-71 ft.	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¼ to 3	49%	35½%	¼ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD. EXTRA STRONG PLAIN ENDS

⅛ to 1½	47%	34½%	¼ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	40%	42%	37%
3½ to 6 in. lap welded	36%	38%	33%

	Galvanized		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	28%	26.9%	22%
3½ to 6 in. lap welded	25%	23.9%	19%

Malleable fittings, Class B and C, from New York stock sell at list +15%. Cast iron, standard sizes, 5% off.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled

Per Net Ton		Per Net Ton	
1 in.	$340	1¼ in.	$220
1¼ in.	280	2 to 2½ in.	190
1½ in.	270	2¾ to 3½ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$222.00
No. 12 solid	135.00	170.00	211.00	290.00
No. 10 solid	185.00	235.00	255.00	325.00
No. 8 stranded	235.00	325.00	345.00	450.00
No. 6 stranded	370.00	472.00	625.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	
Coils to 1,000 ft.	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready:

	Each, Net
Less than 12	$0.40
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	.0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	436.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ¼ in., 100 ft. Standard lengths flexible, ⅜ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
⅛	250	$0.05½	Coils...45% Off.. Less coils, 30% off
¼	250	.06	
⅜	250	.09	
½	200	.12	
¾	200	.15	
1	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$22.00
No. 16 cotton twisted	28.40
No. 18 cotton parallel	25.00
No. 16 cotton parallel	32.00
No. 18 cotton reinforced heavy	35.00
No. 16 cotton reinforced heavy	42.00
No. 18 cotton reinforced light	30.00
No. 16 cotton reinforced light	36.00
No. 18 cotton Canvasite cord	29.00
No. 16 cotton Canvasite cord	35.00

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
210-amp. to 200-amp.	25	2.00
55-amp. to 400-amp.	25	3.60
0-amp. to 600-amp.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$5.25 C
0-30 ampere, less than standard package	7.00 C

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B—			No. in	Mazda C—			No. in
Watts	Plain	Frosted	Package	Watts	Clear	Frosted	Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3.35	24
60	.40	.45	100	400	4.30	4.45	12
100	.85	.92	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.24
Hubbell composition No. 5467, standard package 50	.32
Benjamin swivel No. 903, standard package 250	.20
Hubbell current taps No. 5638, standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$13.00	$16.00	$18.00	$32.00
12	16.70	18.80	22.00	36.85
10	23.52	26.10	29.10	50.60
8	31.00	36.40	40.20	70.10
6	.....	.....	62.00	.....
4	.....	.....	83.10	.....
2	.....	.....	122.40	.....
1	.....	.....	161.30	.....
0	.....	.....	189.68	.....
00	.....	.....	230.00	.....
000	.....	.....	282.40	.....
0000	.....	.....	345.50	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$17.00	$21.00	$35.00	$21.00	$16.00	$33.00	$13.00	$17.40	$36.80
10	25.65	28.90	57.45	27.20	31.00	69.00	21.40	24.40	42.75
8	36.45	40.25	80.30	38.00	42.00	78.00	42.35	44.35	.....
6	57.40	61.70	.....	.....	65.00	130.00	64.60	74.60	.....
4	83.40	88.70	.....	.....	93.00	.....	101.75	106.05	.....
2	126.60	132.80	.....	.....	140.00	.....	151.50	.....	.....
1	164.15	172.40	.....	.....	182.00	.....	201.00	258.50	.....
0	.....	206.80	.....	.....	242.00	.....	276.00	285.00	.....
00	.....	278.80	.....	.....	290.00	.....	317.00	330.00	.....
000	.....	341.65	.....	.....	360.00	.....	417.00	428.50	.....
0000	.....	417.05	.....	.....	435.00	.....	516.00	516.00	.....

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap.			⅜ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package +20%
1-5th to standard package +10%
Standard package −15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	50c. lb.
No. 18 B.&S. regular 1-lb. coils	52c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%